UNDER THE SKIN AND INTO THE SOCIAL: EXAMINING THE NEUROSCIENCE OF SOCIAL PROBLEMS AND INEQUALITY

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UNDER THE SKIN AND INTO THE SOCIAL: EXAMINING THE NEUROSCIENCE OF SOCIAL PROBLEMS AND INEQUALITY

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This dissertation examines how and why neuroscience has entered the field of social problems research. A subset of neuroscientists I studied is now doing research with the explicit purpose of addressing poverty, adversity, and inequality. Their foundational claim is that experiences in the world and interactions with other people – an "environment of relationships" – are integral in shaping brain development. I investigate how neuroscientists and policymakers produce scientific knowledge about the developing brain, and put forward a new sociotechnical vision for governance. Those involved in this project understand themselves as using science to advocate for a more just society that takes responsibility for the health and well being of its most vulnerable and disadvantaged citizens. Despite these good intentions, my neuroscientist interviewees found themselves at the center of controversy during their early careers. Critics from within the scientific community were worried that the research was based upon eugenicist and racist assumptions. The neuroscience community eventually accepted the work, and the controversy subsided. More recently, however, the studies have gotten wider coverage, and a similar strand of criticism, albeit from outside of the scientific community, has resurfaced.

Through ethnographic methods, I studied the knowledge production and policymaking practices of this group, as well as the controversy that ensued and how my participants react to it. I pay close attention to the science-policy relationship, and show that building neuroscience-based policy requires extensive negotiation amongst actors, where they must contend with both social and scientific concerns. The production of a

new narrative called the "Brain Story" exemplifies this process. I found that neuroscience brings new attention to age-old problems, and positions itself as a powerful new voice in the arena of early childhood development by pulling together discourses of science, economics, and our moral responsibility to children.

I argue that the research is at once a reflection and repudiation of biomedical modes of analysis. Though this approach values biomedical evidence about the individual, scientists I interviewed believe that the best way to solve social problems is by intervening at the level of the social. Though well-intentioned, the research may produce unintended consequences.

BIOGRAPHICAL SKETCH

Kasia Tolwinski was born and raised in Red Deer, Alberta, Canada. She has an undergraduate degree in sociology from the University of Alberta, and a master's degree in sociology from Concordia University in Montreal. She was awarded both the Social Sciences and Humanities Research Council (SSHRC) Master's Scholarship and Doctoral Fellowship. Kasia enrolled in Cornell University's graduate program in the Science & Technology Studies in the fall of 2010 to pursue research in the social studies of the contemporary life sciences. She won the Sheila Jasanoff Prize for best graduate paper in 2013 for her research on epigenetics. Upon graduation, Kasia will start a postdoctoral fellowship in bioethics at Geisinger Health System. There she plans to study the ethical, legal, and social implications of genomics in health care.

For Sean Montgomery

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A Road Paved with Good Intentions

When Sean,[1] a neuroscientist and psychologist, submitted a grant proposal requesting funds to do a PhD studying the effects of trauma on brain development, he encountered an unexpected response:

> One of the members of that review panel called my graduate advisor and said, I just read this grant application that [Sean] did, and said, what kind of person is this, is he a psychopath? Like what kind of person would take these young children having these kinds of problems and want to focus on the brain? (Interview Sean)

Similarly, Jill, an expert in cognitive neuroscience, encountered vehement objections to her research into the impact of poverty on the developing brain:

> I'll tell you that the early, my early attempts to get funded to do this research were all rebuffed with really scathing reviews calling me-, basically name-calling, saying I was a reductionist, saying that I was pathologizing poor children, that I was suggesting that poverty is a brain disease. I mean, these are in quotes in reviews. (Interview Jill)

For Sean, this strong rebuke came at the beginning of his graduate career in the early 1990s. This criticism was painful because he was motivated to do the work to help traumatized children. Jill was already a successful neuroscientist when she embarked on a new project addressing the neurocognitive correlates of socioeconomic status in the early 2000s. Her goal was to bring her very successful neuroscience career to bear on questions of inequality, with aims to address the root causes and effects of poverty. Along with the criticism she recounts above, she was also called a eugenicist. Why did these scientists with noble aims of improving society, helping children, and addressing serious social problems get accused of

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[1] While many interviewees gave me permission to name them, I have used pseudonyms to protect their privacy. The only exception to this is when I discuss Nancy Mannix, one of my key informants, who I discuss later in the chapter.

being psychopaths and eugenicists? How did good intentions with desires for social justice apparently go so wrong?

Sean, Jill, and their lab members moved forward with their good intentions for social justice, and continued the work with the little funds they could cobble together. And importantly, they maintained that they were good scientists producing credible data about how experience and social life get into our bodies, in particular, our brains. Today, they feel vindicated. The studies Sean and Jill eventually produced are now considered a source of credible scientific knowledge, and many actors are keen to use that evidence to change policy, especially with respect to early childhood education, social services, and medical and psychological practices. The past and present controversies around the work, scientists' responses to those critiques, and negotiations around neuroscience-based policymaking form the basis of this dissertation. Has policy been enacted, and to what effect? What kinds of visions for the future of science, governance, and responsibility emerge?

"This Is Your Brain on Poverty"

Insights in this cutting-edge subfield of neuroscience, which I will call "social developmental neuroscience" (SDN)[2] suggest that the very architecture of the brain is built, sustained, and altered by social experiences in early childhood. This work asserts that social life, often referred to as an environment of relationships, has a fundamental impact on the developing brain, and that children's brains are particularly sensitive to both positive and negative experiences. My dissertation is about the role of neuroscience in debates around the origins and nature of societal ills like poverty, health disparities, and crime, especially as it relates to questions of governance and the formation of social policy. In the last 10 years this

[2] "Social developmental neuroscience" is a name that I have created for the purposes of this dissertation. I explain my rationale for naming the field in chapter 2.

research has expanded, and researchers from a number of fields are now trying to understand how experience impacts biology, and most significantly, how the experience of adversity is crucial in the complex process of brain development. Social developmental neuroscientists are interested in how experiences become "biologically embedded." Experiences in early life alter an individual's stress neurobiology and gene-expression, for example. This biological embedding, much of which happens in childhood, is thus theorized to have a significant impact on the future health and cognitive capacity of children. The brain is a significant node in these biological processes. The policies and practices emerging from these scientific insights are in their infancy, but policymakers, scientists, public health officials, and other concerned actors imagine the work to have an expansive and comprehensive impact in the fields of health and early education in the years to come. Their hope for the future is that brain development will become central to discussions of how to build better families and a healthier society. It is so far unclear the extent to which their good intentions have changed public and policy imaginaries on a broad scale. However, my research suggests that these are their aims, and that they have had some measure of success. Might the brain become what I will term a "node of governance?"

Poverty and trauma are the most common sources of adversity the scientists and policymakers I studied take up in their research. Poverty has been particularly interesting to a subset of researchers studying the links between socioeconomic status (SES) and the brain.[3] These researchers have utilized brain-imaging techniques like functional magnetic resonance imaging (fMRI) to measure how surface area and volume of certain brain regions differ

[3] A Google search of "this is your brain on poverty" a play on the popular "this is your brain on drugs" PSA of the 1980s and 1990s, yields over 1.8 million results. The top result is a 2017 Scientific American article covering a key study from the field I analyzed.

across SES. While scientists suggest that these studies can be used as scientific proof that inequality is biologically damaging and should be mitigated with progressive social policy, there has been debate and discomfort about locating these problems within the very bodies of marginalized children, and potentially labeling disadvantaged children pathological or brain damaged. A central aspect of the dissertation is controversy about the role of biological evidence in governing society and improving the capacities of individuals. Neuroscientists I interviewed, especially those aiming to understand how socioeconomic status affects brain structure, have been called eugenicists, phrenologists, and racists for closely associating ability with (seemingly obdurate) biological structures. Critics are also concerned that this kind of research reconfigures socially caused impairments into individual, biological problems.

I enter into this topic as a social scientist with interests in social justice. I champion studies, from any discipline, which aim to understand and mitigate poverty and inequality. Yet, as a critical analyst of scientific knowledge and health, I began the project wary of scientific or scientistic analyses making causal arguments about the biological mechanisms underlying poverty and inequality.

Brain Matters

What could neuroscience add to discussions of poverty, and why were neuroscientists interested in social problems in the first place? I embarked on this research endeavor curious about the entrance of scientific and arguably (bio)medicalized reasoning (cf. Conrad 1992, Clarke et al. 2009) into what is usually the domain of sociology. What were neuroscientists measuring, and what were they arguing? Why does the brain matter? While trying to understand why people are interested in the brain to make sense of social problems

like poverty, crime, and inequality, an even more basic question occurred to me: why study the brain at all?

When I search the term "brain" or the phrase "why study the brain?" online, I find links to neuroscience basics – discussions of neurons, synapses, anatomical structures, and so on. It is only when one delves a little deeper into these online sources and publications that we can see a key assumption of neuroscience, and even psychology itself. The brain is the seat of the self, the organ at the center of it all, the electric, primordial goop that is somehow machine, human nature, soul, and self. Popular magazine *Psychology Today* sums it up like so: "Neuroscience aims to understand how a person arises out of a clump of squishy matter" (Psychology Today n.d.). The texture and tactility of the brain is often emphasized in these most basic descriptions of neuroscience: squishy, jellylike, delicate, and so on. This description of the feel and substance of the brain is often set in contrast to its phenomenal and ineffable power. The brain, too, is subject to our Cartesian tendencies. In *A History of the Brain: From Stone Age Surgery to Modern Neuroscience* (2015), psychologist and neuroscientist Andrew P. Wickens expresses a similar discourse of substance dualism when describing the enigmatic quality of the human brain. In the preface he writes:

> As far as we can tell, spinning around on this small planet of ours, the human brain is the only thing in the cosmos capable of consciousness, free will, and self-reflection. It has also been described as the most complex object in the universe – a biological machine that transcends itself to become greater than the sum of its parts. […] Yet, all this great complexity does not get close to explaining the really special property of the mass resembling congealed porridge inside our skulls. In 1942, neurophysiologist Charles Sherrington referred to the human brain as an enchanted loom – a machine with physical bit-and-bobs, which was supplemented with the very special added mysterious ingredient of consciousness. In fact, these two types of 'thing' are scientifically irreconcilable. He could not conceive how the mechanical loom, however complex, became enchanted, and over 60 years later we still do not know the answer. It is arguably the greatest scientific mystery we face today, although one we should theoretically be able to solve, since the answer lies inside our heads. (xii)

What are the stakes of studying the brain? For Wickens, it is nothing less than unlocking mysteries about life itself. He continues: "The solution to this perplexing puzzle is important for it will not only ultimately explain who we are, but also give profound insights into other conundrums such as the nature of the soul, the relationship between mind and body, and perhaps even a greater understanding of the physical universe" (xii). For Wickens and those like him, knowing the brain means understanding life itself, all of it. Perhaps his is an extreme position, but it does represent a broader tendency to view the brain as key to understanding the self and behavior.

I often asked my interviewees what their beliefs were about mind and brain. Most respondents would lament that tricky issue, yet they also suggested that they could not study neuroscience if they did not believe that the brain and mind were one in the same, and that the brain is the origin and most important component of selfhood. When I asked this question, it seemed silly. Of course the brain is at the center of everything, one PhD student named Aaliyah said, "without it, we cannot live." Though she believes that the brain is what makes us who we are, she did question why other organs are not given the same status. "We cannot live without a heart or lungs," she puzzled out loud, "so why aren't we our hearts?" (Interview Aaliyah). Modern subjects do not tend to understand those body parts as essential to our selfhood. This point was brought up during a conversation with other scholars involved in the social study of neuroscience. Why are we our brains, but not our other organs? Why does the brain have this special status, at least in this culture and time period? For the PhD student above, the brain is what makes us uniquely human. All other human parts are just mechanisms without the enchantments. Fernando Vidal (2009) suggests that modernity has ushered in a subjectivity based on brainhood. He terms this self the "cerebral subject." Human beings no longer have brains, rather, they are brains (6). It should not be

too surprising then, that the brain becomes a locus for understanding modern problems, including social problems.

Harnessing Biological Evidence to Make Sense of Social Life

I interviewed scientists and policymakers who study neuroscience, early childhood development, and adversity for this dissertation. They are neuroscientists, psychologists, epidemiologists, educators, doctors, philanthropists, and social workers. These interviewees are interested in, and even passionate about, social problems like poverty and adversity, but want to understand these issues scientifically, and more precisely, biomedically. Their analyses are admittedly and necessarily reductionist, deterministic, systematic, and statistical (Interview Michael); they acknowledge the advantages and disadvantages of this research perspective. Whatever the disadvantages of reductionism, they find value and make meaning through understanding social problems biomedically. They contrast this scientific way of understanding the world with other modes of analysis, like those performed by historians and anthropologists. This is a classic example of what Thomas Gieryn (1983) calls "boundary work," where scientists uphold certain fields (most often their own) as scientific and others as not. I discuss this boundary work in more detail below.

My interviewees value the knowledge from neuroscience immensely; they are cerebral subjects *par excellence*. One interviewee, Jill, sees humans as biological, neurological systems at a fundamental level, so it is self-evident to her that biological evidence is best suited to understanding human beings, even with respect to their social lives. She goes on to discuss the social environment, saying she will not ignore it because "it is part of the physical system that through deterministic processes shapes the body and brain." Evidence from neuroscience, especially that detailing the biological mechanisms that underlie all human behavior, is neither merely useful nor confirmation of social and behavioral research.

Research that describes a relationship or gives evidence of correlation does not, from her perspective, offer a complete, thorough, or perhaps even accurate accounting of a phenomenon. Only evidence of mechanism can provide definitive answers. For her and other researchers like her, what neuroscience offers is something definitive rather than suggestive. In short, biological evidence about social problems is essential because they sincerely believe it is the truth, or at least more true than any existing paradigms. A study of the brain brings into view the essence of the phenomena.

My interviewee Krystin sees the use of biological evidence in service of social problems as positive development for another reason. Biological evidence, from her perspective, is an essential component of making care and intervention effective, efficient, and rational. What was especially interesting about her view was that she positioned evidence-based interventions against what she understood as top-down expertise. For her, an evidence-based approach is more grounded and in touch with lived experience, whereas expertise is potentially rigid, disconnected, and implemented from on high. She understands biological evidence as more personal and patient-centered. It is worth noting that while she and other scientists tend to frame social problems in biomedical terms, they still value interventions at what we might call the social level – they advocate for increased funding for social programs rather than clinical intervention into the body itself. A key contribution of this dissertation, and one that surprised me, is that neuroscientists valorizing a biomedical view onto social problems are not focused on individual, biomedical interventions. Despite a reductionist and biomedical lens, my interviewees argue that interventions should target the social and population levels.

I am going to suggest throughout the dissertation that my interviewees hold some views that critics of biomedicine and some STS scholars might be surprised by. The way that

my interviewees understand the brain is slightly different than the "brain as origin" or "we are our brains" discourse. Though I understand the neuroscientists as still essentializing subjectivity as a matter of brains and neurochemicals, I see a refinement of that discourse in light of a new emphasis on the formation of the brain through development, environment, and relationships, often in early childhood. Viewed in this way, the brain itself is a product of not only biological processes, but social ones as well. Many interviewees, while understanding the brain as the most important part of human self and biology, also see the brain as a mediator between environment and biology. This new vision of the brain requires a new set of social relations to combat social ills like poverty. I will expand upon this observation in this dissertation. Does this new scientific understanding of the brain produce different kinds of social realities? Does it challenge mind/body dualism? Does the research truly bring social life into its analysis?

This dissertation also calls attention to the more complex and intertwined relationships between categories often understood as binary opposites, like inside and outside, social and biological, and nature and nurture, to name just three sets. This is evident in the work of the scientists I study; rather than maintaining the social and the biological as discrete and separate categories, these researchers understand these ideas as intimately and intrinsically intertwined. For instance, scientists in the areas of epigenetics and neuroscience argue that the question is not nature *versus* nurture, but how does nurture *affect* nature (Interview Donna)? Other researchers are interested in another side of this relationship: how does nature affect how one experiences nurture, more specifically, how do genes shape a person's vulnerability to the environment? The point here is that these relationships are complex and contested, and that scientists are engaging with these more nuanced theories of life, both social and biological.

Feminist scholars of embodiment Elizabeth Grosz (1994) and Anne Fausto-Sterling (2000) discuss methods of disrupting dichotomous thinking. They offer the Mobius Strip as a model for how we might move beyond binary thinking, especially Cartesian dualism where mind and body are separate and hierarchized. The Mobius Strip appears two-sided, but is actually one-sided with inside and outside flowing into one another seamlessly. We often think of bodies as having an inside – biology (genes, brain, organs) – and an outside – culture (environment, relationships, society). Grosz and Fausto-Sterling argue that there is neither inside nor outside, and use the Mobius Strip to suggest that biology and culture cannot be easily distinguished. This focus on the mutually constitutive and intrinsically intertwined nature of categories and worlds thought distinct is similar to what Bruno Latour (1993) calls hybridity. The researchers I studied pull together social life and biology in novel ways, and I see them pulling together ideals of political life and lab life similarly.

In my own analysis, I aim to take up these scholars and disrupt an either/or formulation of biology's use in governance. Rather than proclaiming this kind of knowledge as either a) innately emancipatory, or b) dangerously oppressive to the subjects of knowledge, I take the middle way. I suggest that a science of biological embedding is not merely evidence of a renewed ascendency of an individualistic, biomedicalizing, molecularizing, and perhaps neurologizing discourse of the self and health, as has been suggested by many critics. It is true that the work arises within that social and historical context, however, its use and the discourses around it suggest strong commitments to social understandings of disease and social problems. I do not, however, want to suggest that it is only a source for positive social change. Despite positive intentions, ideas may be used in unanticipated and unsavory ways.

While this more complex and nuanced understanding of *bios* and *socius/anthropos* suggests that scientists take the social into account, it remains to be seen if this perspective truly integrates social analyses, especially the kinds that humanists would be supportive of. These kinds of neuroscience claims enter into sociological and anthropological debates, but are their analyses social, or are they scientistic and positivistic attempts to assert the power of neuroscience in all areas of academic inquiry? As Darling et al. (2016) argue, does biological research only count social life insofar as it can be molecularized and fit into quantitative and reductionist research models? Importantly, do neuroscientists' claims to accounting for the social lead to delegitimizing social analyses that are less "scientific?"

My goal in this dissertation is to understand, through discussions with neuroscientists involved in this subfield, how and why neuroscience entered into debates about social problems. Further, I detail how neuroscientists conceptualize and measure social life. My research offered an opportunity to understand knowledge production in fields making sense of human development in its context, through the interaction of biology and sociality, nature and nurture, and genes and environment. This dissertation contributes to this growing body of literature in the social studies of gene-environment interplay research. I ask how neuroscientists intervene in discussions of poverty, trauma, and governance, and why they feel compelled to do so. How and why do they believe that biological evidence should be used in the service of governance? What is the impact of using biological evidence in such a way? I also want to understand how debates and controversies about the subfield unfold. My work here also takes up issues of science communication and science-based policy. My first introduction to this work was through literature attempting to pull neuroscience into policy. So in addition to a close examination of knowledge production, I offer an in-depth analysis of how actors I term "policy-engaged" negotiate what counts as science-based in the context

of communicating key ideas and bringing new policies into being. How do pertinent actors communicate the neuroscience to policymakers and the public? Which claims make it into those discussions? How do they negotiate which knowledge counts? And what are they trying to accomplish?

Early on, it was clear to me that both scientists and policymakers were harnessing scientific knowledge to do progressive political work. This impression led me to ask some of the broader questions raised in this dissertation. For one, how does this marriage of science and politics work? While STS scholars like Sheila Jasanoff (1987) have always claimed the interdependence of science and politics, many are discomfited by that claim because they believe that science should be apolitical and objective. One of my goals is to analyze that relationship, and to show that science and politics seep into one another at all points along the way.

Literature

Nikolas Rose's Foucauldian work on the life sciences (2007) and neuroscience (2010, 2013) have been formative for my theoretical orientation. I share many of his questions and concerns with respect to using neuroscience to make sense of social life, and take them as a starting point for empirical analysis. The dissertation offers concrete evidence about the emergence of neuroscience as what I call a "node of governance." In a 2010 article, "'Screen and Intervene': Governing Risky Brains," Rose analyzes neuroscience from a critical perspective, focusing on the impact of neuroscience as a mode of classifying, intervening, controlling, and also producing new kinds of individuals. He has also initiated discussions on biomedical interventions into childhood, which resonates with what I do here. Rose suggests that development and childhood are central for the "screen and intervene" ethos of neurobiology. He points out one particular consequence of neuroscience research: the

"emergence of a new human kind: the susceptible individual, […] the person with an elevated neurobiological risk of being the perpetrator or aggressor of violence" (Rose 2010, 96). Following Ian Hacking (2002), Rose believes that new knowledge claims bring new types or kinds of subjects into being. Crime and the notion of a criminal subject do, in fact, figure into the discourses I analyze. In videos and documents created by the Harvard Center on the Developing Child (one of my major sites of analysis) crime and community decay are probable outcomes of failing to intervene on individuals in early childhood.

Rose also suggests that "biology here is not destiny" and that "susceptibility over a life-course [is] a consequence of biography, experience, and environment" (2010, 96). If biology is not destiny, then there is a strong imperative to intervene at the level of biography, experience, and environment. As will become evident from the policy outcomes put forth by some developmental neuroscientists, the goal is to quite literally shape young minds; their aim is to target experiences and environments that affect developing brain architecture, especially in children under the age of three. In *Neuro: The New Brain Sciences and the Management of the Mind* (2013), Rose and Abi-Rached argue that early intervention starts in childhood "because the brain of the developing child is more 'plastic,' believed to be at its most open to influences for the good (and for the bad)" (15). Under this logic, policies target risky individuals when they are presymptomatic, preventing potential harm to the individuals themselves and those around them. They argue that "[n]euroscientifically based social policy thus aims to identify those at risk – both those liable to show antisocial, delinquent, pathological, or criminal behavior and those at risk of developing a mental health problem – as early as possible and intervene presymptomatically in order to divert them from that undesirable path" (15). My dissertation begins by questioning whether what Rose and Abi-

Rached argue is indeed the case, and I do so by analyzing how neuroscience-based policy is built and implemented.

I also examine Rose and Abi-Rached's arguments about who is made responsible for intervening in the lives of at-risk children. Early prevention can, of course, be lauded for improving health outcomes, but they remind us that:

> in situating the origins of all manner of social problems and undesirable forms of conduct so firmly in neurobiology, even in a neurobiology that is itself shaped by the environment, we see a repetition of a strategy that we have seen innumerable times since the nineteenth century – to prevent social ills by acting on the child through the medium of the family: a neurobiological explanation for the persistence of social exclusion in terms of a 'cycle of deprivation' grounded in the inadequate parenting provided by the socially deprived. (16)

From what I have thus far reported about my interviewees, one can imagine that they would agree with some aspects of Rose and Abi-Rached's analysis, but might also bristle at the suggestion that they are blaming "socially deprived" families for their inadequate parenting of individual children. In fact, they believe that they do quite the opposite. To help make sense of how my interviewees might feel blindsided by criticism of their well-intentioned work, I turn to Jenny Reardon (2005) and Steven Epstein (2007). Both Reardon and Epstein describe how and why troubles emerge, often despite the good intentions of researchers. In *Race to the Finish: Identity and Governance in an Age of Genomics*, Reardon tells us that scientists at the helm of the Human Genome Diversity Project were surprised to be strongly critiqued and accused of racism, especially considering that they were explicit in their desire to be sensitive to and protective of the racial/ethnic minorities in their project. Without doubt, these scientists meant to do good, not just for science or their own careers, but arguably for humanity. My work here follows from Reardon's; I investigate scientists' experiences of doing research, their motivations, their reactions, and the complex and perhaps irreconcilable contradictions that doing scientific research and social justice together entail.

In *Inclusion: The Politics of Difference in Medical Research*, Epstein argues that projects seeking to unseat *l'homme moyen* (the average man) as the standard experimental subject had the noble and important goal of expanding the scientific definition of which social categories count as representative of the human population, particularly in the case of clinical research. This effort to include a diverse population in medical research was successful because it emphasized biological differences across sexes and racial/ethnic categories. Epstein notes that this move, while having positive effects, also carries the potential of reifying the categories of sex and race through scientific means. Naturalizing claims about race, gender, class, sexuality, and other contentious categories opens the door to familiar and very uncomfortable arguments about innate inferiority and biological essence.

While research in the "social developmental neuroscience" field yields us powerful and compelling scientific evidence that we must address poverty, we can imagine a whole new set of bioethical concerns emerging. It may be the case that the projects I speak of valorize neuroscience at the expense of other, equally plausible social explanations. Are biological explanations of socioeconomic status helpful to disadvantaged populations? Are they also in some ways disempowering, solidifying a sense of inevitable economic failure over the possibility of a better life? What happens if certain children are thought to lack brain capacity because of the poverty they experienced in childhood? Are certain children and adults essentially "broken" if they have not been "fixed" by age three, and must they be subsequently abandoned?

I began my inquiry into this area with a strong belief that scientific discourse sets the very conditions of possibility on human experience, or put otherwise, limits what can be said and done, and which lives are possible. The very notion of locating social phenomena like poverty and inequality in the biology of its least powerful members made me uncomfortable,

as did the linking of childhood experience with long term individual capacity and ultimately community success and stability, precisely for the reasons Rose, Abi-Rached, Reardon, and Epstein outline. In fact, this is initially what I thought my dissertation would be – describing the problematic effects of biological research that too strongly locates subjectivity in the brain. I now suggest, following the work of Michelle Murphy in *Seizing the Means of Reproduction* (2012) that this kind of project is illustrative of what she terms a double vision, which she builds off of W.E. DuBois' notion of double consciousness. Murphy's aim is to

> […] ruthlessly historiciz[e] these past feminist efforts as one might any other scientific endeavor, while doing so from a point of deep investment in feminist technoscience studies as a critical epistemological and material project that values entanglement and sits in a genealogical relation to the practices examined (23)

Murphy argues that the feminist self-help movement is source of liberation, but that it also reinscribes dominant modes of being, potentially reflecting the very values it was meant undo. Medical anthropologist Rayna Rapp (2000) gestures to a similar issue in her analysis of amniocentesis, asking "[h]ow are we to discuss the simultaneously eugenic and liberating agendas of prenatal testing" (2)? Murphy notes that feminist self-help can be seen as "both a symptom and diagnosis of its moment" (32). She suggests, following a Foucauldian perspective, that these practices are neither wholly exploitative nor wholly productive (24). She argues, correctly I believe, that a great deal of Foucauldian work focuses too much on the ways that practices foster social control, and not enough on the ways that disciplinary power feels good and produces a sense of responsibility and identity. While feminist self-help is mobilized to fight current political and social formations, it cannot help but be thoroughly imbued with those logics. Or in the least, efforts to fight off one form of oppression may produce other forms. White feminists may have been disrupting the patriarchy from the 1960s and on, but they were also participating in dominant discourses of

liberalism and governance. And at the same time, women of color were being forcibly sterilized in large numbers, and their birth rates were closely scrutinized. These biopolitical projects were unevenly felt across race and class. The productive and repressive flows of power were evident in individual women, and also at the level of the population. Michelle Murphy's discussion of double vision is useful to understand the complex, multidirectional, multi-causal nature of this science-society knot and its contradictory causes and effects, what it enables and constrains. This double vision exists in these spaces where neuroscience meets inequality; scientists and policymakers enact knowledges to fight rugged individualist, biomedicalizing, and essentialist logics, ultimately producing new kinds of ideas of selves and society, but also acting within the bounds of the very logic they seek to disrupt.

Central to my research are questions about scientific discourse, the production of consensus, and how scientists explain and justify their work. There are a number of classic texts in science and technology studies on scientific discourse that make sense of how scientists both constitute and explain research, and in particular controversial knowledge claims. Discourses are linguistic or symbolic tools that do political work for scientists; they have an effect on the social organization of the field, accounts of its history, and the ideas it produces. G. Nigel Gilbert and Michael Mulkay (1984) put forth theories and methods for attending to scientific discourse. They argue that analysts cannot take scientists' account of a given phenomenon at face value, and that there is no "definitive account" (2) of social actions, even in science. They take those scientific accounts or discourses as data themselves, and analyze them as part of a larger context. In other words, they examine these discourses critically, and see them as scientists' way of "establish[ing] the character of their actions and beliefs in the course of interaction" (14). Scientific discourse, both text and talk, is not a straightforward accounting of the science or the field, but a representation that is actively

constructed by scientists. The scientists I interviewed characterize their work in particular ways. They want to convince different audiences that their research is both legitimate and ethical. This ensures that they continue to win grants, secure employment at prestigious research universities, and gain the approval of their peers. This credibility grants them the opportunity to shape science and policy in the future. And in this case, the neuroscientists I interviewed are expanding the scope of their research to investigate social issues like poverty. If they want to carve out a new domain, they must discursively construct the field as a credible source of knowledge. Further, since criticism of the type I describe above with respect to Sean and Jill often assails the character of individual scientists, my interlocutors felt compelled to respond that they were legitimate and ethical researchers. These actors deploy this kind of discourse to rescue their reputations, both personal and scientific. After all, science that is informed by racism and eugenics is discredited, not only in terms of morality, but also in terms of biology.

Another common assumption about science is that the scientific facts are uncontroversial and stable before they are translated and applied to policy. Jasanoff (1987) argues that this belief is false, and that in actuality, the science/policy relationship is far more recursive, with policy often closing contentious scientific debate. Hilgartner's (1990) work on popularization likewise interrogates a dominant view of the production and dissemination of scientific knowledge. He critiques the prevailing wisdom of a hard and fast distinction between real scientific knowledge and popular science. Popularization is thought to produce either appropriate simplification of ideas, or pollution and/or distortion of scientific truth. While scientists and policymakers maintain these distinctions to legitimize their political and scientific goals, these critical literatures suggest to us that these boundaries are discursively constructed. These ideas are consistent with Thomas Gieryn's (1983) research on boundary

work, in which he suggests that scientists legitimize knowledge claims by characterizing them as science, and delegitimize others by characterizing them as non-science. Scientists maintain boundaries between science and policy, real science and popular science, and science and non-science to maintain the credibility of their own practices. Throughout the dissertation, I treat science and policy as a hybrid entity. Scientists and policymakers I spoke with tend to draw and reinforce the idea of boundaries between science and policy. I investigate these claims critically, and ask why they reinforce these boundaries. And what are the consequences of drawing these lines for policymaking?

On a closely related note, scientific consensus does not emerge miraculously as a result of the accumulation of scientific research. It must be crafted through social processes. Gilbert and Mulkay (1984) maintain that accounts of consensus are also varied and individual (139), but they also argue that there is regularity in the ways that scientists produce consensus, which they understand to be a "kind of collective phenomenon *par excellence*" (112). In *Science on Stage* (2000), Hilgartner likewise problematizes consensus, suggesting that scientific texts and reports produce and reveal the appearance of consensus (and ostensibly definitive knowledge) but "conceal the history of their own production" (19). Such claims to scientific consensus – and in the case of Jasanoff, law and policy decisions – function as closure mechanisms (Bloor 1973, Pinch and Bijker 1984) in scientific debates. The authors I have listed emphasize that claims about boundaries, consensus, or the nature of the field always have an ineradicable political dimension. When policymakers I studied produce materials and facts that constitute the science in particular ways, they produce a specific story of brain development that holds specific groups responsible and offers particular kinds of solutions. They pose some social arrangements as more conducive to proper brain

development, and by extension, certain political and social conditions as more biologically appropriate for healthy development over the life course.

Context and Methods: Crafting the Dissertation

I took an ethnographic approach to the research, immersing myself in this world where possible. I conducted approximately 60 formal and informal interviews across sites detailed below, and they constitute the bulk of my evidence. Another significant source of data was the neuroscience-based policy symposia series where I was a participant observer. I attended them in 2013 and 2014. There I wrote extensive field notes, conducted informal interviews, and took part in efforts to communicate science to the public and to build science-based policy. I also collected policy documents, popular writing, and scientific articles related to my topic. I made sense of written materials through close and critical reading strategies. I tried to get a sense of the key methods used by my interviewees by viewing experiments.

Subjects

My interviewees were mostly scientists, but also policymakers. In chapter 3, I will call this group of researchers, policymakers, and all those in between "policy-engaged" actors. I interviewed most of them in-person, and used a digital audio device to record our conversations. Where in-person interviews were not possible, I spoke with participants via Skype or telephone. Most conversations lasted for approximately an hour. I took sparse notes during our conversations, but also took more in-depth field notes immediately after my interviews. The interviews were semi-structured – I used a standard interview schedule, but allowed for the conversation to emerge organically. I asked them about their academic careers, current research, debates in the field, the nature of the field, questions about brain development, genetics, and experience, their interests in policymaking, and any challenges

they faced in research, policymaking, and science communication. I had these interviews transcribed, and I coded the data, manually and occasionally with the help of ATLAS.ti, a software program for analyzing qualitative data. I looked for recurring themes in the interviews, and took a grounded approach. When I found myself overwhelmed with empirical data, I brought my focus again to the theories and ideas that first informed the project. In such a way, I tried to balance an empirically grounded approach that stays close to the data and actors with insights gleaned from theory and secondary literature.

From my engagement with the Harvard Center on the Developing Child, which I discuss in detail below, I knew that I needed to speak with researchers investigating the consequences of adversity for brain development. Adversity is a broad concept, and I eventually learned that this included work on trauma, stress, and poverty. The researchers are a motley crew who find their homes in a variety of academic departments, using different methods, and addressing diverse research questions. About half of my interviewees, approximately 30, are researchers in university settings. They belong to departments of developmental psychology, neuroscience, population health, and different subfields in the biological sciences. At least five were also medical doctors who maintained their clinical practice in addition to their research. A number of them are program or department heads, and almost all of them run their own laboratories. Additionally, I was able to speak with one health economist, and several professors in a policy program. I also spoke to six PhD students, and three postdoctoral researchers, several of whom have gone on to become tenure-track professors. I had the opportunity to speak with several program managers and research coordinators associated with the researchers mentioned above. I argue that while they are diverse, my interviewees form a of loosely organized group because of connections they have to each other, the policy links they propose for their research, and the ways they

have been interpolated into neuroscience-based policy discussions. I found a number of groups of researchers whose aims converge. This is not an exhaustive list of all of the research that makes its way into these policy discussions, and I was not able to interview all the scientists involved in the work – this was neither feasible nor necessary. I do believe that I spoke with enough actors who are important in the controversy and involved in policymaking to provide specific insights into how this instance of neuroscience-policy emerges. To better understand how policymakers figured into this narrative, I conducted both formal and informal interviews with policymakers, practitioners, and knowledge mobilization experts. A number of the scientists I mention above who work in universities fit into this category as well. At least 10 of them have extensive involvement in policymaking and knowledge translation efforts. I conducted three formal interviews and two informal interviews with knowledge mobilization experts. I also spoke with approximately a dozen practitioners who had been tasked with implementing new communications strategies and practices that were based on SDN discourse.

My initial interviewees helped me gain access to their collaborators and peers. Most had connections to each other's research networks. A significant portion of these interviewees were members of interdisciplinary research entities, like the Canadian Institute for Advanced Research or the National Scientific Council on the Developing Child. I mined the publications of these researchers, not only to understand their scientific ideas, but also to seek out common or canonical works in the field. This enabled me to better understand the network of publications and documents that has emerged from the field, and to get a better sense of which researchers are important in both the more recent and longer history of the research. It also gave me a sense of the disciplines they were drawing from. This is significant, I argue, because of the breadth and interdisciplinarity of these fields.

I built this network of interviewees, by first speaking with scientists at my home institution, Cornell University. Those interviewees made me aware of one group studying the neuroscience of poverty. The head of this group is Jill, and she became one of my most important informants. I visited Jill's lab, and I spoke with her current and former students. Her lab has produced at least four other researchers who now run their own labs: Nicole, Owen, Bogdan, and another woman who I was unable to contact. I spent time at Nicole's well-established lab, and also interviewed Nicole's students for my study. Jill and her scions typically use fMRI (brain scans) to measure the differences in the brain structures of children from different socioeconomic backgrounds. Jill described this work as descriptive, meaning that it shows that brain structures vary as a function of income. This descriptive work is insufficient for her, and her ultimate goal is to understand the molecular mechanisms that produce these differences.

I also interviewed a group of researchers who worked in the late Clyde Hertzman's lab, which focused on early development. As I interacted with all of my participants, they made me aware of a variety of public health projects concerning early childhood development. The research and outreach work of the late Clyde Hertzman was well known and widely respected, so I also made a trip to the University of British Columbia (UBC) in order to understand how similar ideas were being produced and disseminated in distinct ways. Hertzman was known for having a one-man travelling show that he brought to communities in British Columbia; his scale of analysis and dissemination was at the level of the community, and he sought out opportunities to tell communities about the specific developmental and health issues they were facing. While Hertzman died suddenly and unexpectedly in 2013, his institute is still in operation, and many academics work to carry on

his legacy. This is a highly interdisciplinary group composed of researchers studying the health of children – they are epidemiologists, epigeneticists, clinicians, and psychologists.

Along with these groups of interviewees, I also spoke with individual researchers who made significant contributions in these areas of study. My initial interviewees often put me in touch with researchers important to the field. I located others by looking at policy documents and citations of my other informants.

To get a broad understanding of how neuroscientists hope to shape policy, I made another ethnographic foray to a joint neuroscience and policy program at an R1 university. I interviewed the graduate program director, students, administrators, and professors involved in the program. Other interviewees came from my participant observation at a neuroscience-based policy symposia series, which I discuss below. I interviewed a number of policymakers who put on the conference, and others who designed the knowledge dissemination strategies.

Setting

My introduction to these areas of study began when I saw the materials produced by the Harvard Center on the Developing Child. I knew I was interested in the growing power of neuroscience to speak definitively about health, individual identity, and potentially about society more broadly. I was looking for an aspect of neuroscience to hone in on, and was intrigued by the Harvard Center's focus on the formation of what they termed "brain architecture," and their explicit goals to change policy around early childhood. What drew me in further was that in my home province of Alberta, Canada, a group called the Alberta Family Wellness Initiative was explicitly using Harvard's videos and policy documents to increase awareness of brain development to change policy, especially around early childhood. The Harvard Center's aim is to transmit scientific findings about early childhood and the

development of the brain in plain language in order to appeal to both policymakers and the public. My initial reaction to these materials was a sense that the neuroscience was being harnessed for a specific task – to speak for disadvantaged children and families, and to work on their behalf to improve their lives. Their goal of speaking about the role of early experience, especially that linked to inequality and adversity in the formation of social problems struck me then, and still strikes me now, as potentially transformative. Creating social change and support for social programs with scientific evidence seems to me a powerful political strategy. The Harvard Center on the Developing Child and the network growing around it gave me the opportunity to understand the hybrid nature of science, politics, and governance.

A key site for the dissemination of the Harvard Center's information, influence, and philosophy is the Canadian province of Alberta. Accordingly, this became a key site for my research on the relationship between science and policy. Albertan philanthropist Nancy Mannix[4] had been in contact with researchers at the Harvard Center on the Developing Child because she was interested in using science to better the lives of children and the community as a whole. Mannix's initial concern had been combatting addiction, and bringing evidence-based policy into action. She, like many other experts, came to understand addiction as a brain disease. The more she understood about this area, however, the more convinced she was that this social problem had its origin not only in the brain, but in childhood trauma that shapes the brain. My first experience doing ethnographic research in the field was at a neuroscience-based policy symposia series put on by Mannix and the

[4] Nancy Mannix is a key figure is this arena, and is very transparent about her role and motivations, so I have not given her a pseudonym. She is quite easy to identify as she is the leader of the Alberta Family Wellness Initiative.

Alberta Family Wellness Initiative (AFWI). Henceforth, I will refer to this as the symposia series or the neuroscience-based policy symposia series. I was a participant observer in this symposia series, which met for two consecutive years, 2013 and 2014, and I worked with a group of practitioners from that series on a project disseminating the "Brain Story" intermittently for approximately four years, from 2013 to 2017. I took extensive field notes during my time at the symposia series, which each lasted a week. I also took notes during my periodic conference calls with my team and organizers for the four years we were in communication. We were in contact over the phone approximately two times per year. This symposia series was attended and supported not only by the Harvard Center on the Developing Child, but also the government of Alberta. Though the vast majority of participants in the neuroscience-based policy symposia series were Albertan, policymakers and scientists from other countries and other Canadian provinces were in attendance, either because they were key scientists in the field (and often from America) or were looking to implement similar policies in their provinces or countries of origin. Scientists gave lectures at the symposia series and were also involved in shaping these scientific discourses for policymaking. Their intent was to offer a biological and neurological explanation for how experience affects the developing brain, and often results problems like poor mental health and addiction. Conference goers and organizers alike mentioned three major studies quite frequently: 1) The High/Scope Perry Preschool Project (Weikart 1967), a longitudinal study on the impact of preschool for disadvantaged children; 2) the Bucharest Early Intervention Project (Nelson, Fox, and Zeanah 2014), a study famous for demonstrating, through brain scans, that Romanian children in institutional care have smaller brains than those cared for in families; and 3) the CDC-Kaiser ACE Study (Felitti et al. 1998), an epidemiological research project linking adverse childhood experiences with adult health problems. The symposia

series was built upon these ideas; these studies helped set the stage for the activities to come. While I was arranging my fieldwork in Alberta, I was also seeking out other research entities doing the kind of science that was being referenced in the materials from the Harvard group. At this early point in the research, I thought there was a stronger distinction between the scientists and the policymakers. Those at the Harvard Center are more thoroughly in the policy camp, but they do have a cadre of scientists – the National Scientific Council on the Developing Child – as part of the organization, and as an integral part of the policymaking machine. I further extended my network of participants by looking into the research networks of scientists on that council. I soon saw connections between people like Clyde Hertzman and council members (and later, from my other interviewees). One organization that several shared membership in was the Canadian Institution for Advanced Research (CIFAR). It describes itself thusly:

> CIFAR fellows take on tough questions that span disciplines. The answers they require can only be reached by international, interdisciplinary teams working together over a sustained period of time. Our 14 programs tackle questions over four broad areas: improving human health, creating successful societies, using technology to make life better, and sustaining life on Earth. (www.cifar.ca/research)

One of these 14 programs is Child & Brain Development. The major question this program addresses is: "How do early childhood experiences affect lifelong health?" From what my interviewees told me, CIFAR is unique in that it encourages outside-the-box kinds of thinking, and puts very few stipulations on research outcomes. In essence, the institution funds leaders in research to gather together to discuss problems and potentially find solutions to those problems without any strings attached; that is, without any expectations around deliverables such as studies or publications. My interviewees tell me that this was a very open and freeing process that allowed for innovative interdisciplinary collaboration.

This mode of research collaboration allows researchers to simply be together in one room, speak creatively, yet frankly and without jargon, propose wild ideas, and flex their intellectual muscles. The Child & Brain Development program was founded in 2003, renewed in both 2007 and 2012, and is composed of 20 members. They include the following in the list of disciplines: "behavioral, developmental, molecular, and evolutionary biology; behavioral genetics; epigenetics; cognitive and developmental neuroscience; biological, cognitive, and developmental psychology; biological anthropology; epidemiology; public and environmental health; [and] social biomedical science."

CIFAR's Child & Brain Development program summarizes the kinds of scientific research I saw across many sites and interviews, and also gestures to potential societal ramifications quite nicely:

> Researchers with the program in Child & Brain Development want to know how adversity and enrichment in early childhood affect mental, physical, and emotional health throughout a lifetime, and how the problems caused by early adversity can be abated or reversed.
>
> This program has led the way in moving beyond the debate about "nature vs. nurture," and instead has helped establish that it is *interactions* among genes and environments during early childhood that guide human development.
>
> The program examines the neurobiological mechanisms that are governed by those gene-environment interactions and how they determine individual differences in children's development and health. Researchers are also concerned with the larger societal differences in outcomes when children grow up in poverty and when they are reared in more supportive, sustaining environments (www.cifar.ca/child-and-brain-development, emphasis in original)

Though not completely representative of the kinds of research all scientists in this area conduct, the ideas above reflect the concepts, fields, and methods I have encountered in this interdisciplinary schema. Here we see discussions of early childhood, adversity, enrichment, poverty, nature and nurture, life course, gene-environment interaction, neurobiological mechanisms, and potential links to policy. Neuroscience is not the only discipline that

touches the brain; many other fields, like the ones listed above, can contribute to discussions of how the biology of the brain is formed and how it functions.

I also looked to my home institution, Cornell University, for researchers involved in a number of fields. I knew I might want to speak with people studying neuroscience, psychology, development, and environment. I had an informal interview with a member of the Department of Human Ecology who showed me the lay of the land, and connected me with key researchers at other institutions. I made another contact at Cornell in the Department of Human Development, which is situated in the College of Human Ecology. It is here where most research in human development and psychology occurs on campus. Research questions in the College span broad issues, many which concern the complex questions of how we live in the world and how to optimize our health and well-being. The issues are broad because of a commitment to interdisciplinarity, but also because the topic – human development from conception through old age – spans the life course. This seems an all-encompassing, perhaps holistic, treatment of human development. On its department website, it states that undergrads can get their degree "through the exploration of the psychological, social, cultural, and biological development of humans from conception to old age, focusing on the processes and mechanisms of growth and change over the life course." Students might find in this department a place to tackle the complexity of making sense of the cultural and biological human in her many contexts. This department is also where labs testing physiological responses through electroencephalography (EEG) and functional magnetic resonance imaging (fMRI), those measures most evocative for my research, find their home. I observed experiments there, and also spoke with lab managers and technicians to better understand these popular methods in neuroscience.

Unfortunately, I was unable to see any fMRI studies in progress. This is at least partially due to the fact that they are so expensive to conduct. Researchers do relatively few experiments, and often run new analyses on existing scans from other researchers who share their data. Scanners are in short supply and are used during the day by doctors for clinical examinations of patients. There was no opportunity to just go see the equipment. I have had the experience of being in a scanner for an MRI, and am aware of some of the difficulties involved in scanning such as making the participant comfortable in the small, very noisy space. In my naïveté, I had hoped that the graduate students in the labs I visited could give me a closer look at the equipment and tests. This was not possible. The labs in a number of research centers, to my disappointment, looked like average office spaces with cubicles and computers. One lab did have two turtles, and I used this unique feature to break the ice with lab members and discuss issues in a casual manner. As a result, I have field notes about our discussions of nature and nurture debates, often with references to and jokes about the turtle residents.

I began the project with an eye to comparing the differences between science-policy formation in Canada and United States. Due to the inevitable opportunities and challenges of research, the scope of the project and research questions changed. This question is still one I want to flag for readers, and engage with as I expand this project into a book, but it is not taken up in the dissertation. Beyond wanting to draw comparisons between the United States and Canada, I had other reasons for choosing these as my sites. My primary rationale is that the majority of the significant actors in this subfield of neuroscience are American. By happy accident, Alberta, Canada, where I hail from, is a key site for the production and dissemination of the "Brain Story." Not only was this site convenient, it was essential to understanding how the science and policies of this network have emerged in recent years.

Sketching the Road Ahead

My analysis of the knowledge production practices and policy outcomes of this subfield begins with an accounting of the scientific research and its controversial implications. I then move to a discussion of how science-policy is made in spite of disagreements about the evidence. I ask why neuroscience is an effective rhetorical tool, and I outline how discourses of neuroscience combine with other dominant narratives, namely economic and moral, to reinvigorate old discussions of poverty, inequality, and child development, and grant these issues a new sense of urgency. I then detail how neuroscience discourse, what I will call "social developmental neuroscience" (SDN) discourse, has been used to these ends. I end the dissertation by coming back to the controversy that first drew me to this research, namely that scientists undertaking it operate via a eugenicist and racist logic that transforms poverty and other social problems into biological issues. Critics believe that the research ultimately positions children who grow up in poverty and trauma as permanently brain damaged, their life courses significantly diminished, and their impact on the community negative. There is reasonable concern that this research program medicalizes social problems, and looks at these issues through a biologically determinist lens.

In Chapter 2, I outline the major scientific issues salient to the interdisciplinary field of early childhood development. Bounding this interdisciplinary field was a research challenge. I use two definitive reports to do so, one from the National Academies of Science and another from The Canadian Academy of Health Sciences. Here I pull out the key scientific issues, and also highlight some issues pertinent to the field that are not mentioned. While describing the science, I also introduce the audience to the controversy that has followed the scientists who built this interdisciplinary area of inquiry.

I illustrate that scientific consensus around this issue is more complicated than the reports suggest, and examine how this complicates the policymaking process in Chapter 3. While the pronouncements by policymakers and some scientists project a vision of the scientific issues as settled, and the policy outcomes as fairly straightforward, I argue that this veneer of consensus is only achieved through a great deal of debate and negotiation between multiple parties.

I use critical analysts of discourse, especially Maarten Hajer (1993) to make sense of how neuroscience has become a compelling new player in discussions of social problems in Chapter 4. I argue that neuroscience brings attention to older social problems in a novel way through its discursive affinity to discourses of economics and morality. In combination, scientific, moral, and commonsense styles of reasoning build a strong case for new social and political orientations to health, education, and governance. By building a discourse coalition of neuroscience, economics, and morality, policy-engaged actors change public perception of the issues, build science-based policy, and advocate for social change.

In Chapter 5, I examine how the AFWI, the Harvard Center on the Developing Child, and the FrameWorks Institute build what they call the "Brain Story." This case shows how a range of actors involved in the policymaking process come to consensus about the science, and how they craft scientific communication to encourage the formation of new scientific and political ideas in their audiences. I use Hilgartner's (2017) notion of a sociotechnical vanguard to suggest that they produce a future-oriented vision of how science and technology can and should shape our lives.

Chapter 6 takes on the controversy always lingering on the margins of this research directly, that of its potentially racist and eugenicist assumptions and implications. I detail that criticism and scientists' reactions to it. In this series of strikingly uniform responses, I see a

new scientific and political discourse emerging. My interviewees reject the criticism in a number of ways, and ultimately argue that their work is aligned with a "social determinants of health" model that provides powerful evidence about the negative effects of adversity. Citing the brain's plasticity, they understand the work as ultimately hopeful. They want their findings to be responsibly translated into education and health policy to help vulnerable populations and improve public health. I found that researchers champion social justice through strategic use of SDN claims, but always ultimately defer to the ideal of scientific objectivity. Perhaps surprisingly for scholars of biomedicine, I suggest that these neuroscientists use their research to put the onus on society rather than the individual. I argue that using biological evidence about the individual to make changes at the level of the social has both enabling and constraining effects. The work has incredible potential, but its perils – namely the valorization of biomedical evidence at the expense of other useful forms of knowledge and potential to label poor children as irrevocably broken – are also evident. I end by asking what our societal responsibilities are in light of this provocative work, and discussing whether or not this research accounts for the social in ways that would begin to satisfy social scientists.

Chapter 2. The Science, The Stakes

In this chapter, I outline the key scientific ideas about neuroscience, early childhood development, and human experience. As I suggested in the introductory chapter in the discussion of methods, the field is broad and seemingly disparate, spanning numerous subfields in psychology, biology, public health, and other fields, yet there are personal and professional connections across the group of researchers and policymakers. Together, they form an interdisciplinary field that addresses shared research questions and interest in social problems with respect to development, experience, and neuroscience, or as is nicely put by my interviewees, how experience gets "under the skin" and "under the skull." They ask: how is our very biology affected by our experiences in the world, and conversely, how does that biology go on to guide our lives? The scientists I spoke with believe in the capacity of science to guide the governance of societies, and they understand their research to have significant implications for life outside the lab.

As I will show, these claims come from researchers doing the basic scientific research; this is not what neuroscientist John Bruer ,author of *The Myth of the First Three Years: A New Understanding of Brain Development and Lifelong Learning* (1999), calls "folk neuroscience," an uninformed use of outdated claims about the brain for the purposes of supporting one's policy claims. I would characterize the claims-making of the scientists I studied as careful and even conservative, and the scientists as well-aware of the limitations of their studies and reticent to call for changes based on their findings. Even though they believe their research has the potential to improve lives, they are reluctant to move "beyond their data" and recommend policy. Despite this conservative stance towards translation and application, the work has been communicated to different audiences and widely reported upon in the popular and policy literature. Researchers have been surprised by the response to their work.

For those trying to understand how socioeconomic status impacts the developing brain, for instance, some of the first critiques came from within the scientific community itself. Many interviewees told me about this early adversity in the field's history, which has only really taken off since the early 2000s. These well-meaning researchers found that their early attempts to gain funding and be taken seriously were thwarted by fairly serious accusations concerning their character and capacity as scientists; neuroscientists within the same subfield were the first ones to oppose these projects. Quite a few of my interviewees recounted this history to me. Critics responded very negatively, believed such studies concluded that poor children were brain damaged, and ultimately argued that these types of research programs amounted to a new eugenics. Though the neuroscience community now accepts this research, many of the journalists reporting on it today stoke controversy with headlines such as "New brain science shows poor kids have smaller brains than affluent kids" (Layton 2015). The comment sections attached to these kinds of articles explode with criticism from all imaginable political and scientific angles. Admittedly, my own interest in the topic began when I saw policy materials linking early adversity, brain development, and negative events along the life course such as crime and low income. This appeared to me a problematic move that too firmly situated social problems like criminality and poverty in biology. Was this a new kind of phrenology? Would such work ensure that poor children are cast aside as hopelessly and innately damaged at the biological level? Was this ushering in a damaging environmental determinism? Very quickly, however, I came to understand that researchers are well aware of this critique, and have nuanced understandings of both the scientific and ethical issues that emerge from their work. Far from being racists or eugenicists, these researchers are politically active and scientifically astute. My dissertation examines just these issues. After presenting the major scientific ideas, I briefly discuss the translations of the

science into popular and policy realms, the controversy within and about this field, and scientists' reactions to such critique.

Bounding the Field

A major question I have had while writing about this field is how this hybrid and interdisciplinary field should be defined. Rather than defining the field myself, I have turned instead to focus on how the researchers themselves define it. Over the course of my interviews, I began to understand the connections between my participants. When we spoke they highlighted key people, papers, methods, arguments, implications, and importantly, collaborations and fundamental disagreements. Consequently, I came to understand this network and the ideas, methods, and claims they shared. I will call this interdisciplinary field "social developmental neuroscience" (SDN) as a convenient shorthand. I do this to suggest coherence around research priorities and interests in social issues. This is not an actor's category. Most of my interlocutors label themselves in more specific ways that reflect their methods, institutional affiliations, and prior training.

After being steeped in studies from multiple fields, I aimed to come at some coherence or basic accounting of the science underlying these claims. To better describe the nature of this field and its foundational ideas, I found reports and other documents giving broad overviews of the major knowledge claims and central concerns in the area of childhood development and adverse experiences. I found 33 comprehensive reports compiled by expert panels that touch upon topics of early childhood, brain development, neurobiology, gene-environment interaction, health, adversity, and policy. They did not necessarily cover all of these topics, but often covered several. Many were authored or edited by well-known researchers in the field. Some were monographs or reports produced by major institutions like the Institute of Medicine and U.S. National Academy of Sciences or

the MacArthur Foundation. Others took the form of scientific literature reviews. Others still were policy statements, policy documents, or informative documents produced by non-profit organizations promoting healthy child development. One example of this kind of report is *Gray Matters* (Presidential Commission for the Study of Bioethical Issues 2014, 2015), two volumes detailing the ethical issues emerging out of neuroscience.[5] Another is *From Neurons to Neighborhoods: The Science of Early Development* (2000) a report produced by the National Research Council and the Institute of Medicine, edited by Deborah Phillips and Jack Shonkoff, of the Harvard Center on the Developing Child. These kinds of reports are the culmination of long-term projects taken on by specific research networks, many of which were funded by the MacArthur Foundation. Significant research networks for this field include research networks on Socioeconomic Status and Health Early Experience and Brain Development, and Law and Neuroscience. There are likely more reports than the ones I found, and additional reports can be expected, especially as interest in the field grows.

I take the themes, facts, publications, players, discussions, and potential policy implications listed in these documents as evidence of how key actors bound the field of study and the kinds of questions and concerns they see as relevant. I do not take this as a definitive view on what the scientific field truly is or should be, rather, I take the actors' iteration of key studies, questions, and people as constitutive of the field itself, a hybrid network that emerges through such efforts. It also confirms what I found from my attempts to map the field; the expert panels themselves must wrestle with ambiguous boundaries and diffuse sets of priorities, questions, methods, concepts, and findings.

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[5] *Gray Matters* is a bioethics report that is primarily concerned with discussing the ethical issues that emerge in designing neuroscience research, and the implications of that research on society at large. The second volume delves into issues of cognitive enhancement, capacity and consent, and the intersections of neuroscience and law.

My reading of the reports thus illustrates how expert panels constitute an emerging science of early development, experience, and neuroscience. One report even titles a subsection: "The Developing Brain, the Developing Science" (NAS 2015), gesturing to the nascence of the field and its continuing evolution. These reports are not only evidence of how experts characterize the science at this moment in time; they are also important documents that are intended to guide policy and interventions nationally and internationally. The policies these expert panels want to enact have the potential to affect children on a broad scale.

Scientific Evidence about Early Childhood Development

To manage the data, I focused on two of the 33 reports. How the field is bounded is not my primary research interest, and it was outside the scope of my research to analyze all of these documents. I chose the most recent reports that covered most, if not all, of the topics I listed above: early childhood, brain development, neurobiology, gene-environment interaction, health, adversity, and policy. I used these reports to guide my discussion of the major scientific ideas shared by my interviewees and other participants. The reports I discuss below frame themselves as comprehensive summaries of scientific reviews and key studies in the field. Both devote considerable space to discussing the science in great detail. Considering the speed at which the science moves, it is important to give the most recent works greater emphasis. I began the project interested in understanding the relationship between science and science-based policy in Canada and the United States, so one report is Canadian and the other American.

The first report is by The Royal Society of Canada & The Canadian Academy of Health Sciences Expert Panel: *Early Childhood Development: Adverse Experiences and Development*

(2012), edited by Boivin and Hertzman.[6] This report argues that it is "generally accepted that child, adolescent, and adult mental health, effective functioning and well-being all result from a complex array of biological, social, and environmental factors interacting over the life course" (5). The expert panel treats this idea as so self-evident, in fact, that the report does not provide any citations for the claim. The report makes clear that scientists regard finding evidence for the biological mechanisms through which early experience is transmitted, or biologically embedded, as absolutely essential. The expert panel aimed to understand major questions about early development, especially the impact of what experts in psychology, medicine, public health, and social services call Adverse Childhood Experiences (ACE).[7] That expert panel sought to identity which experiences have an impact, and explain their effects and how they occur. The panel was especially interested in understanding how adverse experiences affect brain structure and function. Finally, it sought to understand the evidence for the effectiveness of particular interventions against adverse experiences. Henceforth, I will refer to this as the CAHS Report.

The second report is from the U.S. National Academy of Sciences: *Transforming the Workplace for Children Birth Through Age 8: A Unifying Foundation* (2015), *edited by* LaRue and Kelly.[8] The purpose of the report was "to focus on the implications of the science of

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[6] The entire report is 159 pages in length, and contains approximately 744 citations. The section I focused on was 38 pages long. Two chapters of the report are of particular interest: "Chapter 2: Early Adversity and the Developing Child: The Evidence from Longitudinal Research;" and "Chapter 3: The Neurogenomic Science of Early Adversity and Human Development."

[7] Adverse Childhood Experiences (ACE) are measured through a 10-question tool, the ACE Score Calculator, which social workers and health professionals give to their clients and patients. See Appendix A for this tool. I discuss ACE and the Felitti et al. (1998) study in more detail in chapter 5.

[8] This report was 620 pages long. The sections I paid close attention to were 41 pages in length, and contained close to 150 citations. The chapter "The Interaction of Biology and

development and early learning for care and education professionals who work with children from birth to age 8" (2). This report lays out the basic neuroscience, and is also notable for its discussion of prenatal exposures and experiences. In the rest of this section, I will refer to this as the NAS Report.

Emphasis

Gene-Environment Interplay

The reports are very similar in their basic orientation and recommendations, especially in the sections I focused on. While from the titles, the CAHS report appears more general, and the NAS focused on the workplace, they share much in terms of science, especially the causal model, and policy. There are some small differences between them despite this fundamental similarity. One slight but notable difference between the reports is the emphasis they place on the brain. The brain is almost immediately invoked in the NAS Report, and the details of brain development are placed front and center. The CAHS Report, by contrast, discusses the brain and connected systems as a part of a larger causal model. In this report, adversity leads to differences in gene regulation, which in turn affects brain development, and then ultimately leads to changes in health and development. The CAHS expert panel is more likely to mention stress neurobiology than brain development. Neurobiology refers to the biology of not only the brain, but the entire nervous system. This is a minor difference, as in effect the reports both argue that brain development is a product

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Environment" provides a useful representation of current scientific ideas in the field, and builds upon existing reports, such as *Neurons to Neighborhoods* (2000). The report discusses the considerable progress made in the science of development in the 15 years since the latter report was written. Chapter 3 "describes interactions between the biology of development, particularly brain development, and the environmental influences experienced by a child" (55). I also paid attention to a section of chapter 4 titled "Effects of Chronic Stress and Adversity."

of gene-environment interplay. This minor distinction could be simply a reflection of negotiations about how to most effectively frame the report and subsequent documents and policies. This difference in framing may have more to do with how the science is communicated and used, rather than in how the fundamentals are conceptualized. The brain is where many of these interactions between genes and environment take place, and those interactions, in turn, produce differences in brain structure and development. The science and causal model behind either formulation is ultimately the same. Take, for instance, this statement from a discussion of stress neurobiology in the CAHS report: "[t]he brain and involved brain structures serve not only as points of origin within these coordinated stress responses, but also as targets of feedback from physiological processes in the periphery" (47). The CAHS report does understand the brain to be fundamental. Nonetheless, I thought it was notable that the CAHS report made neurobiology rather than brain development the focus considering the strong emphasis on the brain in both policy documents and public discourse, and obviously in neuroscience publications.

Both reports devote considerable space to discussing the complexity of gene-environment interactions. The NAS Report and CAHS Report both emphasize that the question is not genes *or* environment, but genes *and* environment. This is consistent with larger trends in the area of genomics, where an "interactionist consensus" that highlights complexity and the connection between genes and environment has emerged (Landecker and Panofsky 2013). Discussions about the nature *versus* nurture paradigm figure prominently in the reports, but it is introduced as an outdated conception to be replaced by the correct nature *and* nurture paradigm. The CAHS Report claims that the nature or nurture formation so prevalent in conceptualizations of development has greatly hindered our ability to understand these phenomena. In fact, the report offers a directive to its audience: "[f]or too

many years, the overly simplistic nature-nurture dichotomy has shrouded the important and complex interactions between genes, environment, and development, and limited our ability to investigate gene-environment interdependencies. Moving along is overdue" (34). They also offer up a provocation from prominent epigenetics researcher Michael Meaney to disrupt the binary of nature/nurture once and for all: "What is more important to a rectangle, the length or the width?" Later, they frame the discussion of DNA and environment in terms readily understandable to their audience: they argue that DNA "is environmentally responsive, as if our genes were listening to the environment" (49).

The NAS Report argues that development has "historically been attributed to either experiential or heritable causes, depending on the prevailing scientific and cultural view" (64). The panel notes that both genetic and environmental determinism have been common perspectives in the past, environmental determinism in the sixties and seventies, and genetic determinism in the eighties and nineties. They suggest that genetic determinism emerged with the advent of the Human Genome Project, but as many scholars who study genetics argue, genetic determinism has a far longer history than these reports note (Barnes and Dupré 2008, Kay 2000, Keller 2000, Moss 2002). Similarly, a kind of environmental or ecological determinism that upheld climate and exposure as profoundly shaping the body and health has existed in the past and persists into the future. So, these histories are actually quite complex, and point to the fact that nature and/or nurture arguments existed prior to the Human Genome Project. It must also be said that scientists involved in the Human Genome Project did not operate under a strongly determinist logic either; they, too, held more complex understandings of how genes work; predisposing but not determining outcomes IN MOST CASES (Hilgartner 2017). The NAS report, advancing the genes *and* environment position, argues that we must move past the either or formulation:

> Based on more recent research, however, it is now understood that the interaction of genes and experiences guides development and that the key to richer understanding of pathogenesis is an elucidation of how genes and environments work together to produce—or protect from—illness and disorder, i.e., *gene-environment interplay* (65, emphasis in original)

The CAHS Report similarly emphasizes gene-environment interplay, and also makes clear that an additive model in which genetic factors and environmental factors are separate and can be combined is insufficient. In her discussion of problems with the nature versus nurture debates, Evelyn Fox Keller (2010) also disputes a simple additive resolution, arguing that "categories of innate and acquired cannot be represented in this way" (8). Genes and environment, innate and acquired, are not so easily to delineate and measure. The relationship between heredity and experience is not so simple to account for; gene-environment interplay is considerably more complex.

The scientific literature on gene-environment interplay divides it into three types: gene-environment correlation (rGE), gene-environment interaction (GxE), and epigenetic modification (regulation of gene expression). The CAHS Report devotes considerable space to discussions of epigenetics, but both reports are clear that studies of gene-environment interplay are essential to understanding the entanglement of biology and experience; only these kinds of studies can point to the mechanism through which experience is biologically embedded. These assertions are key to their model of the development of the brain because gene-environment interplay "influence[s] developing neural circuits and processes that are directly linked to long-term trajectories of health, disease, and life achievement" (NAS 69). The ultimate aim of these research programs is to understand the actual molecular processes responsible for biological changes. Many challenges are associated with such evocative and promising scientific work. The NAS Report notes that this research has "become one of the most prolific, engaging, and controversial areas of biomedical and social science research"

(65). It is no wonder then that it is "marked by ongoing, sometimes divisive, controversies over methods and interpretation of findings" (65).

Studies of gene-environment interplay, and the policies and interventions that may be based on them, utilize insights from research on humans and non-human animals. As I will discuss below, twin and adoption studies (or what the reports refer to as natural experiments) in humans provide an opportunity to interrogate these research questions. Many of the claims about gene-environment interplay are the result of studies of animals, and have yet to be tested or cannot be tested in human populations. Much early research on epigenetic mechanisms used rat or mouse models. The details of how epigenetic mechanisms work in humans are more controversial in the scientific community (Tolwinski 2013). Likewise, discussions of critical or sensitive developmental periods are informed by studies in animal models, in which timing of experiences can be manipulated and controlled with experimental precision. Given the impossibility of such experimental manipulation of humans, researchers have come up with other kinds of studies that best approximate experimental design. Nonetheless, this negotiation about how data from animal models can be used will continue, and concerns persist about the level of certainty animal studies provide, especially in genomics research that aims to understand complex phenomena like behavior and disease (Nelson 2011).

Both reports are forward-looking and suggest that newer and more advanced methods will better elucidate the causal mechanisms underlying gene-environment interplay. One method already being utilized is the genetically-informed longitudinal cohort study. Another involves the integration of gene-environment analysis into methods called genome-wide association studies (GWAS). Genome-wide association studies provide "an increased

capacity to ascertain multiple genetic factors" (CAHS 36). The CAHS Report speaks of the promise of this technique:

> This relatively new approach will likely identify novel genes and pathways involved with the trait of interest and allow researchers to understand how risk associates with early experience. GWAS commonly uses upwards of 500,000 DNA differences to identify genetic variants that associate with particular traits. Soon the cost for genome wide sequencing will make GWAS a better choice than studying genetic variation one gene at a time. Integrating the G x E approach into genome wide analyses will (1) increase the number of risk alleles identified, (2) relate these alleles to early adverse exposures and (3) investigate how the relative importance of each G x E changes through development and during adulthood. (52)

Experience, Adversity, and Poverty

It is worth noting that the CAHS Report most often uses the language of adversity, while the NAS Report is more likely to speak simply of *experience*, positive or negative. The CAHS Report gives considerable space to a discussion of Adverse Childhood Experiences (ACE), an epidemiological research project documenting the early adverse experiences of 17000 people and their physical and mental health. The NAS Report, though framing its discussion in terms of experience more generally, still discusses adverse experiences, and is fundamentally concerned with the problem of adversity in childhood. Both reports discuss the impact of stress on key biological systems.

A significant source of adversity is marginalization and poverty. While it is noted that children from any background can experience stress and adversity, both reports make clear that "exposure to many [stressors] is unevenly distributed within populations, which can result in disproportionate risk for the marginalized and the poor" (NAS 64). This idea is complicated, however, by an acknowledgement that there are genetic differences in susceptibility to both positive and negative environmental factors, so that two children of the same socioeconomic standing can have far different biological responses to those experiences. Another poverty-related issue the CAHS Report discusses is that although

poverty and deprivation are significant sources of adversity, more research must be done to test poverty reduction interventions with respect to mental health (41).

Notable Absences

The reports infrequently discuss common neuroscience methods such as electroencephalography (EEG) and functional magnetic resonance imagining (fMRI), even though these methods provide some of the most provocative data, especially in the popular literature. Claims about the neurons firing in the brain tend to be incredibly evocative, especially in the contemporary moment, where we find ourselves to be modern "cerebral subjects" (Vidal 2009) *par excellence*. Not insignificant is the fact that visual representations of data, which fMRI provides, are extremely powerful forms of evidence (Coopmans et al. 2014); brain scans in particular are noted for their potential power to reframe our very subjectivities (Dumit 2004). Methods like EEG and fMRI may be used in the twin studies the reports cite, but the techniques are very rarely discussed in the actual reports. This is somewhat surprising given the primacy put on data from scans, especially in popular and scientific discussions of neuroscience alike. Part of this may be explained by the fact that at this point in time the fMRI data provides descriptive, rather than causal, mechanistic, evidence about the role of experience in shaping the developing brain. Descriptive data, though a necessary step along the way to determining causal mechanisms, are less valued (Interview Jill, Interview Danya). For instance, descriptive studies in this area tell us that differences in brain volume and surface area correlate with socioeconomic status, but they do not explain why and how those differences emerge. Researchers in the field argue that only studies of developmental mechanisms can provide satisfactory answers to those highly valued research questions. As noted above, the express aim of the reports and of the field as a whole is to detail how the observed changes in behavior, brain structure, and gene

expression actually occur. Physiological tests and brain scans using technologies such as fMRI have so far been essential for describing and locating fundamental changes, and researchers envision that studies of mechanisms will then be built upon these findings. The reports do mention fMRI and EEG, when the reports summarize research on socioeconomic status and brain development, as of central concern to the methodological designs and analyses in the subfield.

Causality and Mechanism

Both reports state with certainty that there is plenty of evidence that early experiences of adversity are associated with physical and emotional health problems throughout the life course. The CAHS Report makes very clear that longitudinal cohort studies provide evidence for the correlation between adversity and health, and they focus on this kind of evidence in the report. Indeed, they argue that "from a methodological standpoint [these longitudinal cohort studies] provide the 'gold standard' with respect to tracing the long-term outcomes of early adversity" (20). Arguments about correlation, however, only suggest causality. What scientists in this field have been trying to ascertain is how experiences, especially adverse experiences, create changes in physical, emotional, and cognitive health.

What the experts on both panels seek to explain is the causal link between adversity and suffering, and to explain in more detail what researchers in the field know about the mechanisms linking experience and biological change. The NAS cites concept of "biological embedding" from Clyde Hertzman in their report: "[e]motion and the social experiences of early life are deeply and enduringly represented within behavioral development and are 'biologically embedded' in the anatomic structure and function of the growing brain" (58). The concept is again mentioned in the discussion of genetics, environment, and epigenetics:

"environmental influences during childhood can become 'biologically embedded' within the genome of the growing child" (69). Hertzman was a member of the expert panel for the CAHS Report, and his idea of biological embedding is treated in that report as one of the foundational ideas. In fact, the basic research question of both reports can be simplified to this: how does experience get embedded in human biology?

The CAHS Report argues that "new longitudinal cohort studies are positioning themselves to take scientific discovery to the next stage, by integrating state-of-the-art assessments of biological markers of early experience (herein biomarkers) alongside in-depth assessments of familial, school, and neighborhood contexts" (20). These newer studies integrate so-called natural experiments and randomized preventative trials, and are described as the next best option for studying causality in humans. Experimental models, especially randomized controlled trials, are often invoked as the gold standard for establishing causality. The reports position randomized preventative trials as similarly useful for establishing cause and effect. The natural experiments the reports discuss are twin studies and adoption studies, which are designed to parse out the effects of genes and environment. The randomized preventative trials are like randomized controlled trials in the way one group is the control and the other receives the experimental treatment – in this case, an intervention. The most famous example – one consistently brought up by my interviewees and others working in the field, especially practitioners – was the High/Scope Perry Preschool study, which was initiated in the 1960s in the US. This longitudinal study examined low SES and low IQ children, starting at age 3 or 4 and following them into their 40s. The intervention the experimental group received was high quality preschool education; while the control group received no preschool education. The study "revealed a range of long-term benefits […] These developmental gains include higher rates of academic

achievement, employment and income, as well as a significantly lower rate of crime and delinquency, lower incidence of teenage pregnancy and welfare dependency" (CAHS 32). The Perry Preschool study is often used to argue, not only for the power of social programs, but also for their ultimate cost-effectiveness and positive impact on society as a whole. Another often-mentioned randomized preventative trial is the Bucharest Early Intervention Project (BEIP), which also provides powerful evidence that an intervention, in this case foster care rather than institutional care as usual, benefitted children in the experimental group.

Stress Neurobiology

To make sense of how children's social relationships and experiences impact the body, the expert panels turn to research on stress neurobiology. The aim of this research to understand the impact of chronic stress and adversity on the body. It is important to note that stressors in these approaches include not only extreme sources of stress such as child abuse, but "also those that an adult might regard as less significant because they may be less severe although persistent (e.g., parents' chronic marital conflict, poverty)" (NAS 161). So too may intergenerational trauma provide a source of chronic stress.[9] Intergenerational or transgenerational trauma typically refers to situations in which older generations "transmit" trauma to subsequent generations in a variety of ways – biologically, socially, and psychodynamically. Researchers have studied Holocaust survivors and their children extensively. Children and even grandchildren of survivors have been found to suffer as a

[9] Intergenerational trauma is not defined by the report, but the expert panel suggests that "[h]istorical or multigenerational trauma […] can influence cultural differences in responses to trauma and loss" (161-2).

result of the Holocaust. (Kellermann 2001) Similar issues likely result from other forms of trauma as well.

Research on the impact of stress on physiological systems – namely the brain and stress response systems – aims to explain another dimension of how adversity in childhood leads to adult disease. The two systems involved are the autonomic nervous system (ANS) and the hypothalamic-pituitary-adrenocortical (HPA) axis. The NAS report (71-2) explains that chronic stress affects the body because of "the cumulative biological 'wear and tear' that results from the prolonged activation and overburdening of biological systems that are designed primarily for short term activation." Accordingly, chronic stress leads to dysregulation of cortisol production by the HPA axis, which has myriad effects, including changes in immunological response, inflammation, and the functioning of brain systems, especially the prefrontal cortex. Additionally, the HPA axis can become hyper-responsive, causing children to have a heightened reaction to normal stress, or it can become blunted, disrupting the normal physiological processes related to cortisol production. Under stress, the ANS can produce elevated blood pressure, blood sugar regulation issues, and "immune system and inflammation dysregulation" (NAS 73). The CAHS Report similarly summarizes the negative effects of stress on the brain: "these recurrent events [of chronic stress and adversity] lead to exaggerated, maladaptive physiologic responses, escalate disease risk, and undermine health both in childhood and in adult life" (47). One source of chronic stress that both reports discuss is poverty.

Developmental Time and Plasticity

A key concern in both reports is time. In fact, the NAS Report argues that "[t]he central role of time is a recurrent theme in developmental science. The effects of experience change dynamically across the life span, as critical and sensitive periods open and close,

especially in the early years" (70). The CAHS Report notes that adult health is not only a result of accumulated adverse experiences in early childhood, but also that epidemiological data show "that adult disease and disease risk factors [can also be] biologically programmed during critical periods of early growth and development and remain latent until the emergence of pathogenic processes in adult life" (44). Both reports discuss a number of enduring questions for researchers trying to understand the relationship between experience and time: When is an experience most damaging? When do events have to happen for normal development to occur? Are these critical or sensitive periods plastic? Can this neuroplasticity be induced? The NAS Report takes a more expansive view that extends to the very beginning of fetal development. According to the report, biological embedding begins in utero; experiences related to maternal stress, nutrition, and environmental pollutants can affect fetal neurodevelopment. Typically, though, the literature on developmental time concerns experiences in infancy and beyond. The language of critical or sensitive periods is used in the NAS Report: "[d]uring critical periods of development, important experiences or exposures result in irreversible changes in brain circuitry. During sensitive periods, the brain is especially responsive to such experiences" (70). The typical example in both animal and human studies is vision. If a child or animal does not experience visual stimulation because of illness, for example, the visual centers of the brain do not develop to their highest capacity. Thus far, animal models provide the only opportunity to experimentally understand mechanisms of neuroplasticity and critical or sensitive periods. Again, this is due to the difficulty of conducting controlled experiment-like manipulations in human populations.

Most typically, discussions about developmental time are most concerned with the experiences children have at a young age. In terms of intervention and prevention, this

translates to ensuring that children have the right experiences at the right time, and are protected from damaging experiences and exposures. This becomes even more important during those critical or sensitive periods that are theorized to have an impact on overall development and future health. The literature is clear in its assertion that chronic stress during childhood is damaging, but the expert panels also aim to understand which time periods and systems are especially affected. What is notable in the discussion of time, as well as many other themes in the reports, is the focus on social rather than biomedical interventions. In part, this may stem from the fact that neuroscientists have yet to develop these biomedical interventions. However, relatively new research takes aim at neuroplasticity, asking about the molecular processes inducing neuroplasticity. These researchers' visions of the future include the potential to manipulate neuroplasticity, and therefore, to modify the critical or sensitive periods. Unlike previous interventions at the social and experiential level, exploring the possibility of "tweak[ing] chemical switches" (Hensch 2016) is one of the first discussions of targeting the individual, biomedical level. This type of intervention is still very much in the conceptual stage, and will not be available in the foreseeable future. He is nonetheless oriented towards the future, imagining his nascent research as inevitably having an impact. Scientists like Hensch who propose new interventions, drugs, and practices often imagine these developments as unfolding over a longer term, perhaps at the end of their or even their students' careers.

Dandelions and Orchids: Dealing with Individual Susceptibility

Both reports are concerned with the phenomena of differential susceptibility to experiences, positive and negative. Some children appear more genetically susceptible to interactions with the environment than others. This means that when faced with experiences of adversity, some children may be affected and others not; some are biologically sensitive to

context while others appear not to be. The reports do not call this the Dandelion-Orchid Hypothesis, but this formulation has been used by neuroscientists and developmental psychologists Boyce and Ellis (2005) to explain the phenomenon of differential susceptibility, and I find the metaphor helpful and evocative. Some children, it seems, thrive in any number of conditions – dandelions, which seemingly grow anywhere, regardless of experience and environment. These children are less sensitive or susceptible to adversity. Other children, however, are more like orchids, which require very specific and stringent environments and care to grow or even survive. So, though it is the case that

> all children exhibit responsiveness to environmental influences, a subset of children show an exaggerated susceptibility to the character of their social environments […] Such children almost certainly contribute substantially to the uneven distribution of ill health, learning difficulties, and troubled development found within childhood populations. However, they may also benefit disproportionately from positive early interventions. (NAS 76)

So while it is the case that the environment and experience matter immensely, there are individual differences, that are presumed to be genetic, in how these environments can affect children's development. Again, a complex intertwining of genetics and environment is at play in shaping children's development, rendering some more likely to have experiences biologically embed effects in their brains and bodies.

Socioeconomic Status and the Brain

A theme within the reports and also in other literature I have analyzed is the role of poverty on the development of the brain. Major questions implicit in the documents are how stressful is poverty, does it count as adversity, and what are its effects on the brain and body? In both reports, the sections on stress neurobiology emphasize that poverty is a source of chronic stress; accordingly, the experience of poverty produces the biological effects that I have listed above. The NAS Report emphasizes that "[f]or children, poverty often entails the

confluence of multiple sources of chronic stress" (74). The environment of poverty is also likely to be crowded, noisy, polluted, and potentially more dangerous.

The expert panels also give some attention to a significant subfield: socioeconomic status and brain development. They note that researchers in this area have found a socioeconomic gradient in neurocognitive function, especially in relation to language and executive function. Executive function is a term that is used in the developmental literature and policy arena extensively; it is the ability to pay attention, solve problems and tasks, and to concentrate, despite a potentially distracting variety of stimuli. For instance, executive function is required of children in school – they must be able to sit, pay attention, follow instructions, and carry out cognitive tasks over a period of time. Being successful in school hinges upon this neurocognitive capacity. Researchers in the area who focus on socioeconomic status and the developing brain have so far described this relationship and located areas in the brain that they believe account for these differences. They use fMRI and EEG along with psychological testing to better understand the effect of socioeconomic status on the structure of the brain. In the language of the reports, they explore how the experience of poverty is biologically embedded in the brain. For more detail, we can turn directly to a comprehensive literature review of this subfield written by Daniel A. Hackman and Martha Farah entitled "Socioeconomic Status and the Developing Brain" (2009).[10] Hackman and Farah begin the review as follows:

> SES is invariably correlated with predictable differences in life stress and neighborhood quality, in addition to less predictable differences in physical health, mental health and cognitive ability […] The relevance of SES to cognitive neuroscience lies in its surprisingly strong relationship to cognitive ability as measured by IQ and school achievement beginning in early childhood.

[10] This publication is cited in both reports as well.

> Which neurocognitive systems are implicated in these SES gradients, and what causes the gradients? These are questions for cognitive neuroscience. (65)

In other words, psychological measures such as IQ tests are said to indicate those SES gradients in cognitive ability, but do not reveal the neurological basis of those cognitive gradients: which areas of the brain are affected, or the mechanisms through socioeconomic status creates those cognitive differences. IQ testing and other psychological tests suggest but do not provide evidence for which brain regions are affected. Brain scanning technology like functional magnetic resonance imaging (fMRI) has been used to describe these disparities in neurocognitive function, and in doing so, "provide more direct evidence of the involvement of the prefrontal cortex" (68). More recent publications in this same vein have used data from fMRI to measure differences in cortical volume and surface area (Lawson et al 2013, Noble et al 2015). Questions of mechanism or cause are considerably more complex, but Hackman and Farah suggest that environmental influences like epigenetic modifications and differences in educational quality are likely key factors. They note that this area of research is in an early phase, and suggest that future research like randomized interventions and longitudinal studies are required to better account for the phenomena and make generalizations from them. This kind of positive future orientation to the work, one in which researchers expect significant progress to occur, is characteristic of this field. Scientists like the ones above imagine breakthroughs and developments at just the tips of their fingers, maybe one more grant from coming to fruition.

One methodological challenge that this work, and any analysis of poverty for that matter, must contend with is its intersections with other factors, namely race, as both a social and biological category. Scientists aim to isolate the impact of SES itself through the use of sophisticated statistical methods. Despite their efforts to isolate the role socioeconomic status, STS scholars like Victoria Pitts-Taylor (2017), argue that the aforementioned

scientists' work ignores race as a variable, and thus ignores racism's role in perpetuating inequality.

Reactions to Scientific Claims

In this chapter, I have given a more detailed view of the scientific research that encompasses the development, experience, and neuroscience nexus. The major contributions from the area suggest that there are potent links between experiences in the world and who we become; our interactions with the environment and society are integral to the development of bodies, brains, and selves. These research programs argue that the ways in which genes are expressed, the stress neurobiology system is programmed, and the prefrontal cortex takes shape are inextricably linked to one's social life. While the malleability of sensitive periods is debated, it is still assumed that early childhood experiences are particularly important. The work that has emerged in this field, especially in the field of the neuroscience of socioeconomic status, is now concerned with understanding how socioeconomic status creates differences in the prefrontal cortex. The larger field is interested similar questions about mechanism. It is now established that experience does get under the skin. The questions are now: how do experience and environment get embedded, and how can these pathways be targeted for intervention? Through these scientific claims disruptions in childhood are put forward as having a significant impact on developing biological systems. In such a way, childhood and children are often positioned as important timeframes and locations for prevention and intervention. Controversy has and continues to emerge around this framing. If prevention and early intervention are so important, what is the fate of those children whose experiences are less than ideal? Are they biologically defective? What are the responsibilities we have as a society to nurturing the development of all children?

The scientists involved have put forth a claim that they believe is relatively uncontroversial and now supported by a wide range of studies and fields – inequality and adversity have biological effects – but have sometimes found themselves at the center of controversy. Despite my interlocutors considering themselves quite the opposite of genetic or biological determinists, critics have latched on to just this type of refrain. Critics are concerned with the implications of such work.[11] Pulling together the biological and the social in such a way makes many people deeply uncomfortable. In her discussion of use of neuroscience evidence in Canadian courts, Jennifer Chandler (2015) suggests that biological evidence is a double-edged sword. She shows that biological evidence of brain injury and fetal alcohol spectrum disorder helps explain why people commit criminal acts, and that evidence renders them less culpable for those acts. Measuring culpability is especially important in the courts, and it is useful to have biology as a mitigating factor or even scapegoat. On the other hand, she found that utilizing evidence of brain injury had the effect of labeling offenders as innately and permanently damaged, which ultimately leads them to being proclaimed "dangerous offenders." Because of the state of their biology, their very brains, the legal system tends to frame those offenders with brain injury to be at high-risk for re-offense and considers their rehabilitation near impossible. It appears that any scientist putting forward biological evidence in the service of social change must navigate some rough social waters.

For instance, the most recent studies of cognition and socioeconomic status (cf. Noble et al. 2015) have garnered significant media attention. The scientists in question find themselves criticized from all angles. Most significantly, they have been accused of saying

[11] The reports I studied did not make mention of this criticism.

that poor children have small brains, and this is worrisome given the implication that poor children are somehow biologically inferior to rich children. Add to this concern about class the fact that poor children are often racial minorities, and we are left with an unsettling debate about the abilities (innate or acquired) of poor, minority kids. As I will show in this dissertation, this left scientists in this field dumbfounded because they understand themselves as contributing productively to efforts around poverty reduction and public health. When these scientists have been confronted with criticism, they have maintained that the research has been misinterpreted and its implications exaggerated, often by the media. They further place the blame on people outside of scientific research who they believe problematically extend the nascent work into policy. The problem, as they see it, lies with the premature translation of the research. Those working to translate these findings into policy prioritize using that knowledge to improve life today, not at some point in the future when the science is more clear and unproblematic. There are disagreements amongst scientists about when it is appropriate to translate findings, and over which findings can be translated. The unfolding of this narrative leads me to ask a set of provocative questions. Is scientific study able to productively and unproblematically contribute to discussions of social problems? Does it provide the right kinds of answers? Can biological evidence ever escape its troubled history? How do we ensure that this evidence is not used for purposes we find morally abhorrent? And on a more mundane, but not insignificant level, do scientific claims like the ones above actually make their way into policy discussions? These are all questions that emerge and must be negotiated whenever biological evidence is introduced into a new domain, especially those related to policy. These questions and negotiations suggest that there are never straightforward applications and implications when encountering scientific evidence.

Chapter 3. Science Unsettled, Policy Interrupted? Dilemmas and Negotiations in Policy-Engaged Science

In this chapter, I discuss the controversies and ongoing negotiations about evidence that I have observed in this community. A major theme that emerges from my research is controversy about which evidence counts and when that evidence is settled. I argue here that some of the key neuroscience facts used by policymakers are more contentious than they first appear. Despite the seeming consensus around ideas – as exemplified in the definitive reports in the previous chapter – scientists and policymakers I interviewed still disagree about a number of concepts in the area. A number of my scientist interlocutors maintain that the science is "not there yet" – and argue that existing data should not be used to inform policy, or that only certain pieces of evidence should be used. Those who are more thoroughly entrenched in the policy realm, or who engage with patients on a regular basis, tend to believe there is enough data upon which to base action and improve life for children. Why do they hold different opinions on the usefulness or readiness of science for policy? And how do my interlocutors frame their beliefs as correct, and their concerns as most significant? Though most of the actors I studied believe in the concept of science-based or evidence-based policies, there are disagreements about which scientific ideas should inform governance and how much certainty is required. I suggest opinions about the status of evidence – and accordingly, the ability to act on that evidence – differ depending upon the context and priorities of the participants. I heard a variety of opinions about the balance between certainty and action.

In the above paragraph, I distinguish between science and politics, and scientists and policymakers, but I begin from the premise that this assumption cannot and should not be sustained. I hold that the worlds of science and politics are inextricably intertwined. Following Bruno Latour (1993), I suggest that these seemingly distinct worlds are always

already one, a hybrid entity. Latour suggests that common, modern understandings of the world make the mistake of dividing up hybrid entities of nature/culture and science/politics into separate, dichotomous categories that require different kinds of expert study and knowledge production. As I seek to disrupt just these kinds of dualistic notions in this dissertation, Latour's injunction to treat the world in hybrid terms allows me to begin from the assumption that scientists and policymakers operate in concert (and conflict), acting on the same natural and social worlds, which are not worlds but one hybrid entity. So, rather than valorizing a strong distinction between the worlds and roles of scientists and policymakers, I propose seeing these individuals along a continuum, where they move back and forth, often self-consciously. While these worlds cannot be disentangled, scientists and policymakers often identify as one or the other, or perhaps somewhere in between. This is a result of their training, professional connections, engagement with communities and legislators, and shifting career trajectories. To reflect this hybrid role of scientist/policymaker, I propose all of the actors involved in bringing scientific knowledge to bear on governance are "policy-engaged."

These individuals I term "policy-engaged" maintain that there is a gap between science and policy; where I identify a hybrid, they see two worlds with fundamentally different priorities, languages, and expectations. I observed this theme across my interviews, in the literature, and at science policy conferences. I encountered a number of policy-engaged actors in this field who are primarily involved in research, while others are more thoroughly entrenched in communication, policy construction, and legislation efforts. I also spoke with a number of scientists who appear equally involved in science and policy. Whatever the role, these policy-engaged individuals are concerned with science that has important implications for social issues, and struggle to understand why the so-called

science-policy gap exists and how to bridge it. My scientist interviewees tend to suggest that the science is unsettled and cannot inform policy, while more policy-oriented interviewees tend to see it as an issue of policy being interrupted by calls for more research and data. While this is a common way of understanding the issue, I want to suggest, following Sheila Jasanoff (1987), that science and law – and in this case policy – have a far more interactive and ongoing relationship. Instead of suggesting that there is a gap between science and policy, I will argue that there are dilemmas and negotiations in policy-engaged science. Policy-engaged actors can and do operate in the same science/policy hybrid world, and ask the same basic question: is the science there yet?

Why shouldn't policy-engaged actors make use of scientific findings to better the lives of children, especially when they *know* that poverty, for instance, negatively impacts children's development? Are scientists too cautious or too concerned with truth to thoroughly commit to a translation of science to policy? Though they are understandably committed to the integrity and long-term credibility of the scientific enterprise, the neuroscientists I studied are primarily concerned with using evidence too early or inappropriately. For other policy-engaged actors who are more thoroughly entrenched in the policy world, however, the concern is often about not using evidence early enough. For Joseph Dumit (2014), the use of neuroscience in the courtroom is an instructive example of using and institutionalizing scientific knowledge inappropriately. In his work on the use of neuroscience, brain-imaging, and the law, Dumit warns against the "polemical use of neuroscience analysis" (307). He argues that despite the scientific consensus, neuroscience evidence is used in ways that researchers neither intend nor recognize, often to confirm existing beliefs. Even if neuroscience is used to support more socially just policy, it is not necessarily the case that it should be used for these purposes. He notes that some of the

amicus curiae briefs filed for *Roper v. Simmons* (543 U.S. 551, 2005) – a Supreme Court case that made capital punishment unconstitutional in the case of minors – imagine adolescent brains as innately immature and adolescents as inherently more prone to high engaging in risk behavior than adults. From a neuroscience perspective, this discourse about the adolescent brain is not completely accurate – Dumit words it more strongly, calling it "scientifically inaccurate" and "dangerous" (309). He writes, "neuroscience research into development seems to reveal greater variability in brain maturation than stereotypical views of adolescent riskiness […]. Instead neuroscience findings are almost only used to reinforce the stereotypes" (307). Dumit goes on to argue that evidence from neuroscience is coopted by more powerful discourses. From this it is clear that he believes there is a difference between real neuroscience and the neuroscience-based discourses that find their way into the world. This is a far more conservative stance than is typically taken by STS scholars, who are committed to the principle of methodological symmetry, rather than a sociology of error (Bloor 1979, Collins 1985). Focusing on error treats truth as a teleological endpoint and natural outcome of scientists properly observing the world as it clearly reveals itself. The principle of symmetry allows the analyst a comprehensive understanding of how "good" and "bad" science is produced, and how facts about the world are made rather than revealed. Dumit offers this distinction because he wants to intervene on what he believes are highly problematic uses of science as a kind of truth-machine (cf. Lynch et al. 2008) that codifies problematic assumptions into law. The problem with this viewpoint is that it assumes that there is a truth about adolescent brains that can and should be clearly seen by scientists and then used to build a sound policy. This understanding of science-based policy puts the onus on science to reveal the truth, and for policy to follow naturally from that scientific "truth." It forgets the intrinsically intertwined nature of science and politics, putting responsibility

and power in the hands of scientists, and ignoring the role of social life in the production of scientific knowledge.

Scientists and policymakers that I have encountered are undoubtedly opposed to a polemical use of neuroscience. They agree on that. What is polemic, and what is not, is far more contested. In fact, my interviewees are committed only to proffering accurate and credible findings. Policymakers want to bring science to a domain they believe has been sorely lacking and full of inaccurate and potentially damaging discourses. Most scientists maintain that science-based policy can only be enacted when certainty is greatest.[12] No one involved wants to promote policy based on mere rhetoric. Where, then, does the line between polemics and science-based evidence lie? How is this line negotiated in practice, especially when scientific knowledge is never complete? After all, as Michelle Murphy (2006) and Bruce Campbell (1985) argue, claims to scientific uncertainty can always be made, and are often iterated by those who want to put off regulation and policymaking indefinitely. Claiming certainty and uncertainty are political acts. Scientists also make these claims to advance their own agendas. Trevor Pinch (1981) argues that it is common for researchers who are in the midst of scientific controversy to emphasize the certainty of their own fields while highlighting the uncertainty of competing or adjacent fields. So, here I dig deeper to understand what is behind these calls for certainty and calls for action. I ultimately argue, in the vein of the foundational claims of STS, that the line between using science polemically and factually is not so clear. Perhaps this leads to a more important question – what is good science? STS scholars know there is no god trick (cf. Haraway 1991) that gives us an

[12] While scientists do harness the current power and appeal of neuroscience to make political change, they are critical of the tendency to do so, and always maintain that scientific truth ultimately guides their actions in the lab and in life. I discuss this in Chapter 6.

unmediated and objective view onto the world. The only absolute or universal truth here is that the line between truth and polemic is foggy and contested, and will remain so. Given this, how do we move forward with science-based policy? Certainly, some of my interviewees believe that good science is science that helps children and families, and addresses social problems. Other interviewees worry that this is not enough, and that even science-based policy built with the best intentions in mind can be harmful.

Moving beyond scientific articles and definitive reports – taking a close look at some policymakers and scientists' discourse about evidence and its uptake in the policy realm – gives insight into how scientific discourses are produced and used, and the controversies intrinsic to those processes. Mirroring Stephen Hilgartner's approach in *Science on Stage* (2000), I look behind the curtain to better understand how coherent facts and narratives emerge out of a complex set of practices and relations backstage. So here, I discuss key intellectual debates around two exciting but contentious areas – critical periods and epigenetics. From the viewpoint of my interlocutors, is the science "there yet," and who gets to decide? Then I move to examining scientists' and policymakers' concerns about ushering in more neuroscience-based policy at this point in time.

Science Unsettled

In this section, I discuss controversies within the scientific community about key claims put forth in the reports from the U.S. National Academy of Sciences (NAS) and Canadian Academy of Health Sciences (CAHS) detailed in chapter 2. The reports provide a thorough account of key studies and issues that characterize the field. The NAS and CAHS reports also suggest that some key matters of fact are not yet clear, especially in the case of gene-environment interplay research. Though they acknowledge where knowledge is missing, they also fundamentally maintain that far greater certainty about gene-environment

interplay will emerge in the future, as is evident in their hopeful presentation of the potential of genome-wide association studies and other genetic techniques. The reports suggest that there is a great deal of scientific clarity upon which policy can be built, and that where clarity is lacking, progress will inevitably be made. The expert panels are optimistic about the capacity of future scientific research to come to definitive answers. Despite this acknowledgement of uncertainty, the reports define the field in a specific way and for specific ends; they tend to offer authoritative accounts of science that is settled.[13] We are not privy to what was involved in the making of those reports, especially discussions of what should and should not be included. Nor we do get insight into how authoritative scientific knowledge is made. Seeing how ideas about adversity, socioeconomic status, and the developing brain are built and used outside of the reports reveals far less certainty about major ideas related to critical periods, neuroplasticity, and epigenetics. These arguments are evidence of larger debates about how to produce knowledge about the relationship between society and biology, and also about how such evidence might be translated for purposes of governance. Not surprisingly, unraveling the complex interconnections of society and biology are controversial in the scientific community, and perhaps even more so in arenas of governance.

It is important to note, however, that although discussions of critical periods, neuroplasticity, and epigenetics are common in this arena, my scientist interviewees are not always involved in those types of studies. They are often involved in far more specific projects that run adjacent to these projects or build off of basic ideas in these fields. They mostly employ these studies to discursive, pedagogical, and rhetorical effect. Key studies in

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[13] It is important to remember that the reports themselves are rhetorical tools (cf. Hilgartner 2000).

epigenetics and critical periods, for instance, are deployed to explain the basics of development and gene-environment interaction to a variety of policy-engaged actors and also to a lay audience wholly new to these scientific claims.

Critical Periods and Neuroplasticity

The concept of critical periods in development, especially as it has been used in policy circles, has long been criticized. Most notably, there was a "debunking" of the concept by neuroscientist John T. Bruer in his book *The Myth of the First Three Years* (1999). He was most critical of what I will term the early years discourse, which was prevalent in the mid to late 1990s, and famously championed by Bill and Hillary Clinton. The Clintons and other policymakers argued that caregivers were unaware of the role of early experience in children's development. The idea proposed at that time had the same kernel of truth as much of the current work does: early childhood experiences matter and have a profound impact on the future of the child and society more broadly. Bruer argues that this discourse – especially the idea that what happens in early childhood has an impact on future social problems like criminality – is a kind of folk-neuroscience (3). In a more recent interview, he continued to voice reservations about discourses of critical or sensitive periods, and also to raise serious reservations about research linking brain development and socioeconomic status (Smith 2014). He argues in his book that he began to see many popular articles pushing the early years agenda in the 1990s, and was aggrieved by the exaggeration of claims and sensationalism. He suggests that "[w]hat seemed to be happening was that selected pieces of rather old brain science were being used, and often misinterpreted, to support preexisting views about child development and early childhood policy" (3). He argues that there was no new science, just old science, and that the neuroscience claims were being used as "rhetorical flourishes" (4). Many of my neuroscientist interviewees told me about the

book and the fervor around critical periods. They often used it to emphasize the problems that would arise if data are used haphazardly to inform the public and policymakers. This concern is central in how they think about science translation and building science-based policy. The point about neuroscience as rhetorical flourish is not insignificant; are current projects pushing the early child development rhetoric truly neuroscience-based?

Do other scientists share this critique? In 1999, neuroscientists did agree with Bruer that the science behind the claims was far less certain than policymakers purported it to be. The result was that some furor over the early years died down; Bruer notes the language has changed from critical to sensitive periods, reflecting the scientific consensus that developmental periods are not so clear and delimited. Nevertheless, as evidenced in the reports, policymakers in this area still use the phrase "critical and sensitive periods" today. It also appears that the basic premise remains: a child's experiences before the age of three matter immensely. A more recent policy document from the Harvard Center on the Developing Child clarifies the importance of the early years to a greater extent, and better accounts for change: "A great deal of brain architecture is shaped during the first three years after birth, but the window of opportunity for its development does not close on a child's birthday" (np). So has the science advanced, or is neuroscience still merely a rhetorical flourish to further a specific agenda? As I have suggested above, Dumit argues that the developmental neuroscience is more complex, and if anything, emphasizes variability rather than universal milestones. Some scientists today do not take as radical a stance as Bruer did (largely due to the effectiveness of his intervention), but their views may align quite closely to Dumit's. On the whole, scientists I encountered maintain a more nuanced view of the subject than can be accounted for in reports, the popular press, and policy. By this I mean that reports, press, and policy do not account for what goes on behind the scenes, such as

disagreements or negotiations about what is in those documents.[14] When it comes to the intersection of neuroscience and policy, many of the scientists I interviewed are not convinced that the science is "there yet."[15] My respondents' concerns for accuracy and the responsible use of scientific knowledge in governance tend to make them take a more conservative stance to knowledge mobilization. They would rather hold off on making strong claims about their data until they feel absolutely certain of their implications. The stakes of utilizing science in what they believe to be a haphazard manner prove too high. They worry about codifying inaccurate claims into law and policy, and misleading the public. It might be difficult to put the "bad science" genie back in the bottle.

Neuroscientists tend to understand these critical periods as far more flexible, or plastic, than reports suggest. As evidenced in the Harvard Center report, policy documents do gesture to this plasticity. Current publications suggest that our brains are developing and changing well into the teens and early adulthood (Hensch 2016). For the development of normal vision, it does appear to be true that there is a critical period in early life. Without experiencing the right stimuli during this time, the visual system is compromised. This is also suggested for emotional development (Interview Sandy). However, other kinds of development, especially cognitive, are treated as far more flexible. A leading researcher told me that

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[14] It must be noted that not all scientists hold the same views. They are a heterogeneous group. Further, there are those who occupy some place between scientist and policymaker. These different roles lead to different points of view, as I have so far suggested. Scientists I interviewed who are more thoroughly entrenched in academia, however, remain skeptical about the suitability and readiness of the data for policy purposes.

[15] And, as I will discuss in a later chapter, different interpretations of critical periods and neuroplasticity evidence are key to understanding how neuroscientists respond to critiques that their work has eugenicist implications or positions poor children as brain damaged.

> there doesn't seem to be [a critical period] for cognitive development and that's important to know, right? I mean if we have evidence of critical or sensitive periods in human behavior, it's in two areas. One area is sensory and perceptual, in terms of vision, pattern, vision and binocular vision and all this other kind of stuff and auditory perception, and the second area is language. Other than that, in terms of more complex cognitive functions, it doesn't seem like there's a sensitive period. What we do know is that brain development occurs in a fashion such that circuits are laid one upon the other and it becomes harder with development to learn certain complex things than it is when you are younger. It is easier when you are younger to learn, it's not impossible to learn as you go into your sixties and seventies and eighties you can learn, it's just that the range of learning and the kinds of skills that you can learn is narrowed and the amount of effort that is necessary is greater. And that's the important message there. (Interview Sandy)

While sensitive periods are significant, they tend to be overemphasized. And in the popular and policy literature, critical periods are often interpreted as though anything that happens after the age of three has no impact. It is often claimed in policy circles that finding at-risk children in kindergarten, and even pre-school, is too late. Evidence around critical periods is used to advocate for better early childhood policy, and to be sure, milestones around emotional development and some physical development must be met. Critical periods may also be useful in pinpointing which interventions should be prioritized and when they should be enacted. Specific recommendations like this may be particularly effective in funneling scarce resources into the right channels. Yet, the implications of "early is best" are fraught. This oft-cited implication is part of what has sparked criticism of neuroscientists. What happens, critics might ask, to those children who are older than three? Are they irreparably broken? What does advancing this kind of claim in science and policy do for those who have not had the right experiences during those critical periods? The neuroscientists I interviewed are also concerned about the same issues. For cognitive development, one of the key issues at hand, the scientist quoted above argues that these critical limits do not exist; the brain is far more plastic. They are demonstrably not on board with policies that suggest children's brains are flexible only until age three. They are quite concerned that policymakers are

overemphasizing early development. Despite this hesitancy, the neuroscientists I interviewed report being critiqued for suggesting children's brains may be irreparably damaged; this is precisely the opposite of what they want to suggest to the public. I discuss this issue in detail in chapter 6.

Even for one of the critical periods that scientists agree upon – language – they still make space for flexibility, suggesting that there are no foregone conclusions when it comes to building neural circuitry. When I asked my interviewees about concepts like neural plasticity and sensitive periods, a large number of them explained the concepts to me by using the example of language acquisition. This is a particularly effective example that illustrates the main ideas well. They began their explanation by hooking into a phenomenon that many people observe – children possess an incredible ability to absorb multiple languages. It is much easier for a young child to learn a second language, for example, than it is for an adult. Many of us know this from our own experiences. The scientists would often refer to their own attempts at language acquisition in adulthood, and we would laugh together knowingly because it tends to be hard for adults. For an adult, learning a second language is difficult, though not impossible. It simply takes more effort. The point neuroscientists want to make about neuroplasticity is that some processes are easier to pick up during particular periods in development, usually early life. These are times of greater neural plasticity; learning new skills during sensitive periods is easier because more neural networks can proliferate and strengthen. After many interviewees discussed this example, they would often emphasize that learning can occur outside of these sensitive periods. If a scientist talked to me about language acquisition, they also always told me about the possibility of learning across the life course. Just because adult language acquisition is not easy does not mean it is not possible or worthwhile. Even when discussing the importance

of critical periods, scientists tend to emphasize the possibility of neuroplasticity. Any policy work that too strongly suggests permanence made the vast majority of my scientist interviewees uneasy. Considering that my respondents hold a variety of views on these topics, I was struck by the uniformity of their views in this particular case.

The most groundbreaking research in this area suggests that critical periods are far less critical and, what is more, can be manipulated. Takao Hensch (2016) argues that "new molecular tools for studying critical periods have overturned many of the prevailing ideas. Experiments in animals—and even some human studies—have demonstrated that a critical period might be reopened to repair broken brains well afterward" (66). Critical periods may be altered through the use of drugs, for example. He also suggests that this research can be used to reframe how vulnerable or at-risk children are taught. By using a benzodiazepine to increase the signaling of the GABA neurotransmitter in research on mice, his lab was able to alter these critical periods (68). Neuroscientists believe that the work holds great promise for the prevention and treatment of neurological disorders. We will have to wait a considerable amount of time to see applications of these ideas; Hensch suggests it could "take years, perhaps decades, of research before some of the most ambitious techniques in lab animals reach patients" (68). Though many of these claims are promissory, they introduce a number of bioethical and biomedical issues regarding our desire to optimize our brains and intellectual capacities. In the meantime, it is clear that scientists are thinking about critical periods and plasticity in nuanced ways that are not always reflected in the policy discussions and popular literature. First and foremost, they do not believe that children's brains are fixed in early childhood. Though they do maintain that brains are produced by experiences, their understandings of brain allow for far more transformation and flexibility across the life course. This position, however, may prove untenable for policymakers who want to bring

the best scientific evidence to bear on contemporary issues like child poverty and trauma. I did find that some scientists, especially those more explicitly involved in policymaking, were willing to take a less conservative stance on the use of scientific evidence (field notes). In a section below, I detail how doctors or medical professionals I interviewed were far more likely to say that there is enough good evidence to make policy and improve practices in the clinic. They want to balance calls for certainty with the practical task of building better, more evidence-based policy. While neural plasticity suggests that development is ongoing, those who have commitments to improving children's early life experience, such as pediatricians, are willing to suggest that there is enough consensus around sensitive periods to make policy recommendations and change clinical and education practices.

Epigenetics: A Proliferating Discourse

Epigenetic mechanisms play a key role in brain development, especially under this model of neuroscience, experience, and development. Epigenetics has become a buzzword, and claims around it have entered the popular imaginary; especially significant here is the fact that epigenetics discourses get intertwined with neuroscience ones. Epigenetics research, on the whole, has grown rapidly in the past decade (Haig 2012), with the term being used extensively for a wide range of purposes. These claims have been central to explaining and supporting policy narratives related to early brain development. The definitive scientific reports from the U.S. National Academy of Science (NAS) and Canadian Academy of Health Sciences (CAHS) that I discussed in the Chapter 2 dedicate significant space to discussion of epigenetics, a specific type of gene-environment interplay. The term has been bandied about in the popular press, and at conferences or symposia like the ones I attended. It was at the Alberta Family Wellness neuroscience-based symposia series where I did field work and participant observation that most attendees (practitioners who were often

psychologists, therapists, and social workers) learned what epigenetics meant. Researchers and the expert panels creating the reports alike agree about the most general denotation of the term epigenetic, which translates to "upon" or "outside of" genetics. As part of this basic understanding, the reports add: "[t]he term refers to chemical processes and modification that change the structure, conformation, or packaging of DNA, which in turn facilitate or disallow the transcription (decoding), and expression, of the gene" (CAHS Report 54). For many practitioners and policymakers, epigenetics becomes shorthand for biological processes that are "not genetic," an effect of "nurture" rather than nature, "acquired" and not innate, and "environmental" rather than biological. The word has an almost magical quality; mentioning epigenetics at the symposia series caught participants' attention, and in some instances, it was a catch-all term that explained everything and nothing, and yet required no elaboration. It both simplifies and complicates at once.

This grandiose understanding of the claims does not always match up with what epigeneticists believe. Even the reports argue that epigenetics is one facet of a complex, intertwining of nature and nurture, not the supremacy of nurture over nature. Nonetheless, to those outside of epigenetics, it comes to means "DNA is not destiny," and often has the effect of casting aside the genetic aspects of the biological puzzle. In epigenetics research itself, discussions are much more complicated. Though social developmental neuroscience (SDN) discourse is informed by a more nuanced understanding of epigenetics, in its public and policy context, it tends to present a more simplistic viewpoint on how epigenetics works and what it means. In this section, I argue that though epigenetics is pulled into policy discussions as scientific proof that we must enact better early childhood policy, particularly ones that target pregnant women and young mothers, the reality is that there are arguments between leading epigenetics researchers about the strength of such claims. Leading

researchers in the field are not certain that they can act as a foundation upon which to build science-based policy. Amongst them, there is much disagreement about the nature, significance, and future of the field. Diverging opinions on definition and significance suggest that the field is not yet a stable entity, and that its place in the life sciences remains unclear. Despite this instability, epigenetics is being ushered into practice and policy as evidence for the role of environment in children's brain development. Is epigenetics revolutionary for the practice and epistemology of biology? For all of the revolutionary rhetoric, epigenetics is only revolutionary for a small subset of vocal champions of the field (Tolwinski 2013). The majority of epigenetics researchers I spoke with had far more modest appraisals of the role of epigenetics across the life course and status of the field.

So why is evidence from epigenetics used so frequently in literature and activism related to child development? Do experts believe those championing the field are misrepresenting the science? Yes and no. Scientists within the field may agree about foundational claims in the field, but disagree about how epigenetic mechanisms operate in humans. Debates in epigenetics do not often center around questions about the existence of epigenetic phenomena, especially in certain model systems. Scientists I interviewed were keen to point out that the data supporting the existence of epigenetic mechanisms were very strong; however, they argued about the interpretation, use, and general importance of such findings. As one of my respondents said:

> I don't think people dispute the mechanisms. It's easy to defend the mechanisms because I think the data are quite strong. The question really comes down to how important it is. […] I mean, the question is, how relevant is it? It's not that it doesn't happen, just does it really matter?" (Interview Michael).

And further, is there proof that these epigenetic mechanisms matter in the case of humans? Evidence of epigenetic phenomena that is pulled into debates about humans often comes from studies in model organisms, often rat and mouse. Because experiments control the environment and genetics of animals, they offer the opportunity to study not only behavior, but also the underlying mechanisms or causes of gene expression. The use of model organisms creates dilemmas and poses such questions as how do we translate knowledge from model organisms to humans, how strongly can we make these claims, and can we base policy on them? Both the scientific reports and the symposia series organizers utilize claims from animal studies to advocate for new evidence-based policies to ensure children's health and well-being. Knowledge of epigenetics in plants (*Arabidopsis*) and invertebrates (*C. elegans*) is extensive, but because of the vast differences between these species and humans, it is understandable that these claims are not used to make policy arguments. The most important examples from animal studies are 1) the agouti mouse (Waterland and Jirtle 2003) and 2) rat mothers' licking behavior (Meaney and Szyf 2005). In fact, these two examples were discussed when teaching practitioners at the symposia series about epigenetics. These examples are relatively easy to translate for a lay audience. They also hook into controversial social problems, obesity and mental illness, which make them relatable and important to this audience.

The Agouti mouse study argues that nutrition in utero shapes the phenotype or traits of offspring. This paradigmatic study is memorable because it shows a photograph of two mice, side-by-side, which we are told are genetically identical. The image is powerful evidence of basic epigenetic ideas. These genetic clones express different phenotypes. Visual evidence that shows genetic clones who look nothing alike is a fascinating and important pedagogical tool. Despite possessing the same DNA, one mouse is small and brown, and the

other is fat and yellow (see Figure 1). Such evidence is used to suggest that mothers' diets in pregnancy have the capacity to program their children's weight. With the negative meanings that are often associated with obesity in our society, this example hooks into anxiety about weight. For participants at the conference, the imagery and ideas are quite striking, and they break down some of their most basic assumptions about how genetics works. The image and ideas reframed "commonsense" genetic knowledge, thereby allowing conference goers to think in new ways about development. One of the conference organizers' explicit goals was to undo a popular belief in genetic determinism. This presentation of epigenetics evidence through such evocative imagery encourages practitioners to think differently about brain development, namely to foreground the role of environment.

Figure 1. Image of Agouti Mice. Photo credit: Randy Jirtle and Dana Dolinoy

Another key study proved an equally powerful pedagogical tool, but not because it visualized data. In Meaney and Syzf's now famous study, rat mothers were separated into two categories: anxious mothers who lick their offspring less, and relaxed mothers who lick their offspring more. The pups of anxious mothers turned out to be anxious. Now, this

alone would not be surprising, and the cause could be genetic – mothers passing anxious traits down to their pups. The investigators wanted to definitively test whether it was the licking behavior or genetics that produced traits related to anxiety. To test this, pups were randomly assigned to mothers. The lickers (the good mothers) produced more calm and relaxed pups. Both studies provide compelling evidence that maternal factors (nutrition and behavior) change gene expression. This study of rats and their offspring proved intriguing to the participants of the neuroscience-based policy symposia series that I worked with, and I believe this was the case because it concerned pregnancy and early childcare. Discourses around mother's impact on the developing fetus are well-worn, and already suggest that something other than genetics is at work. Worries about what pregnant women do and consume have been common across history, and are guided by fear of what a woman can inflict upon the fetus, be they anatomical anomalies or drug induced birth defects (cf. Kukla 2005). Pregnancy is already a time of greater surveillance by public health experts, who strongly promote the discourse that experience matters. To be sure, experience, especially as part of the fetal environment, does matter.

In short, narratives about mice and rats are useful for those ushering in a more environmentally inflected developmental model because 1) they use images that produce a shift in their audience's perspective on genetics, and 2) they hook into existing ideas or examples, particularly around pregnancy and caregiving, wherein the audience knows instinctually, anecdotally, and sociologically or psychologically, that experience is fundamental. Hearing that these processes are epigenetic further scientizes, and makes legitimate, these neuroscience and epigenetic claims in the eyes of the practitioners. It may also be the case that obesity and anxiety are themselves hot topics. Mouse obesity and rat anxiety are directly and unproblematically correlated to the same human problems by

policymakers and a collection of epigenetics researchers. But can mouse and human be so readily compared? Not all scientists agree.

Evidence of mechanism, as gleaned from animal models, is highly valued by scientists because they believe it gives them certainty about cause and effect. There is uncertainty around how epigenetic mechanisms might work in humans, however. For those who want to make links between evidence in animals and claims in humans, they must map evidence from animal studies onto human studies. Nicole Nelson (2011, 2018) discusses the complex epistemological and rhetorical work that behavioral geneticists undertake when building the relationship between human behaviors and the model organism they study. In her case, researchers study the mouse to make sense of human problems of anxiety and addiction. In the case of epigenetics researchers, there are similar tendencies to try to use evidence of epigenetic mechanisms in mouse and rat to make arguments about the existence of these phenomena in humans. Evidence in mouse and rat upheld as proof of concept or cause, and epidemiological studies or natural experiments in humans are used to confirm the existence of the same mechanisms in humans. In such a way, these studies propose, for both expert and lay audiences, a plausible mechanism through which experience becomes biologically embedded. Where experimental manipulation in humans is impossible and unethical, these natural experiments and epidemiological studies seem the next best option.

The links between mouse and human have been forged, with some success, by pulling in evidence about the Dutch Famine of 1944. During World War II, disruption of food transport and destruction of agricultural land, along with an unseasonably harsh winter, caused starvation. Epidemiologists have analyzed both historical and current medical records and correlated starvation during pregnancy with higher incidence of health problems such as obesity, schizophrenia and coronary heart disease in offspring in later life. This alarming

correlation along with experimental evidence of mechanisms of transgenerational inheritance in the agouti mouse led a subset of epigenetics researchers to make conclusions about mechanisms in humans. This is an example of how scientists and policymakers who believe strongly in the significance of epigenetics weave together two kinds of evidence to further both the field and its impact. For those researchers, this epidemiological case suggests epigenetic marks are transmitted through human generations, even when there has been no direct study of these mechanisms in humans. Epigenetics researcher Moshe Szyf, an advocate for the field who is often featured in the media, cites the Dutch Famine as straightforward evidence of transgenerational inheritance in humans. Alone, these studies provide insufficient evidence, but layered together, the evidence becomes more viable.

For other scientists, this layering is insufficient. Argues interviewee Michael,

> so these epidemiological studies in the Dutch Famine? Okay, these are statistical arguments, they're compelling changes, but it's very vague in the sense that we don't know exactly what happened. Of course, in that case it was deprivation, but I mean in other cases, we can't necessarily point to something in our diet and say, okay, this has a bad epigenetic effect. (Interview Michael)

When causal, mechanistic evidence is seen as the only route to producing credible scientific knowledge, it is difficult to make claims about humans. Scientists tend to understand such evidence as always uncertain. This kind of uncertainty is less desirable for those aiming to build policy that challenges the status quo. Without evidence of causal mechanism in humans, many scientists are unwilling to make the leap from animal to human, even when they do agree that epigenetic modification occurs in humans. As the interviewee above states, "does it matter?" Many researchers are uncertain if there is a human equivalent to the fat, yellow phenotype. While plants and some animals do seem to transmit epigenetic marks across multiple generations it is not abundantly clear that these marks are transmitted across human generations. Part of this reticence comes as a reaction to grand claims about

epigenetics in humans, and what many epigenetics researchers consider "media hysteria" about the possibility that we do irreparable damage to our grandchildren by our actions today. Certain studies propose that a grandmother's nutrition, development, and mental health affect not only her children, but also her grandchildren. To wit, one popular media article about epigenetics is titled "How We're Already Killing Our Grandkids" (North 2010).

Increasingly, epigenetics researchers study human models. Researchers I spoke to were quick to point out the limitations of their own epigenetics research. Chris, an epigenetics researcher trying to understand the impact of socioeconomic status on gene expression, said "I want to make the point that just because these things are correlated – you have the epigenetic part of this correlate of children's behavior – it doesn't mean it's causal." Again, causal evidence is most valued by my interviewees, and without it, a significant number of scientists I spoke with do not feel they can make claims with certainty. This researcher wants to be very careful and conservative in making claims, which, for him, is just a matter of being a good scientist, and ultimately recommending good policy. He further argues

> While it is very promising and there have been some intriguing studies that have been published, I think there needs to be a broad body of literature and different groups, replication of findings, which has hardly happened just because the field is so new. What you don't want to do is go to policymakers with things that aren't yet certain. But, of course, on the flipside of the coin, we do a lot of public outreach. (Interview Chris)

Here, my interviewee suggests another way that epigenetics evidence might become more credible: replication. So, greater certainty may be on the horizon. Uncertainty about the evidence does not mean for him that scientists cannot be involved in policymaking. There are still claims that he wants the public and policymakers to know. His aim is to inform them that an "adverse set of life circumstances […] can literally make changes to the epigenome, which then might affect health and behavior across the lifespan." Note, however, how he

hedges this claims with language like "can" and "might." So far, the narrative I tell suggests that scientists I interviewed are first and foremost concerned with doing good science. I believe this is true, however, my interviewees are also very worried about supporting policy that has real, and potentially damaging, consequences. Those doing basic epigenetic research tend to have fairly conservative stances on data and policy change.

Again, the strength of these claims depends on the scientist. It also depends on the researcher's ability to negotiate the tricky issue of experimentation in humans. Building upon previous work in the rat model on the epigenetic effects of licking by a caregiver, Michael Meaney and his collaborators sought confirmation of the same process in humans. They aimed to understand the impact of parental care on gene expression, especially glucocorticoid receptors that have been implicated in suicide. To do so, they used a unique sample set of tissue from brains of people who died by suicide. They tested tissue from 36 brains that were donated to the Bell Canada Brain Bank at the Douglas Hospital in Montreal. One of the articles produced by that lab, McGowan et al. (2009), reports that a history of childhood abuse is associated with epigenetic changes. In the epigenetics and neuroscience communities I engaged with, this was a well-known study. It has been widely cited and discussed in the media. As of July 2017, PubMed reports that it has been cited almost 3000 times. In popular articles, the scientists involved speak with great certainty that child abuse produces these changes in gene expression. Part of the reason they can speak with greater authority about this phenomenon is that they found a way to conduct a quasi-experiment on humans – an experiment on human tissue.

But again, those less certain about the precise role of epigenetics emphasize its significant limitations, namely small sample size and the lack of data about causation. There are still so many unknowns in epigenetics research that speaking with certainty is fraught.

Data from epigenetics is exciting and attention-grabbing for the scientific community and public audiences alike. It makes sense that policymakers would want to harness the enthusiasm and hypotheses to productive and progressive ends. However, out of this emerges controversy among epigenetics researchers about the claims themselves and how they should be used. Policymaking, especially based on relatively new scientific claims, produces anxiety in scientists who are concerned that public and policy attention damages the credibility and stability of their growing fields. The examples of debates around critical periods and epigenetics, ideas that have become increasingly popular in neuroscience policy discourse, make these anxieties clear.

The Potential and Perils of Neuroscience-Based Policy

Throughout my fieldwork, I saw policy-engaged actors using what many deem to be cutting edge neuroscience to build policy to help children and address social problems. The status of these claims is contested, with a number of actors suggesting that the neuroscience is incomplete; others I spoke with and observed argue that the evidence is complete enough or that despite this issue, there is enough evidence to move forward with policy creation. A number of people are trying to build science-based policy and improve outcomes by using innovative knowledge dissemination practices. The Alberta Family Wellness Initiative's aim is "turning 'what we know' into 'what we do' using the best available evidence" (Alberta Family Wellness Initiative), and to do this they argue for changing the narratives and core beliefs around development by communicating science to the public, practitioners, and policymakers. They argue that broad knowledge dissemination – better awareness and

understanding of the facts – will ultimately lead to policy change.[16] I have suggested above, however, that the facts are far from clear, and that scientific consensus about key issues is less clear than it appears in the reports and policy documents. For some scientists, neuroscience-based policy should be put off because the data "just isn't there yet." The complexity and controversy a number of scientists discuss illustrates why they find it difficult to make policy recommendations. They emphasize that the scientific knowledge might not be so obvious and clear. Why do they believe it is difficult to bridge the so-called gap between science and policy, and why is certainty so difficult to achieve?

The notion of a straightforward science-policy gap is problematic, especially if we consider science and policy not distinct worlds but rather a hybrid entity. Notions of a gap between worlds maintains boundaries between what is done in the lab and what is done out in the world, what is scientific and what is social. I again want to emphasize the overlapping and mutually constitutive aspects of this relationship. As we know from Sheila Jasanoff (1990, 2004, 2005), co-production is complex and multidirectional, and the co-production of science and policy oftentimes results in policy and law closing scientific controversies. In the rest of the section, I will refer to a science-policy hybrid or co-production. Despite my analytic orientation, my interviewees, along with policy documents and literature, maintain that science and policy are separate worlds. My interlocutors insist upon a gap even as they work in both worlds, often very lithely and effectively. Those lamenting the gap characterize it in different ways. In an article on the science-policy gap, Bradshaw and Borchers (2000) argue that it is often the case that publics and policymakers desire certainty, and that

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[16] In chapter 5, I detail how organizations like the Alberta Family Wellness Initiative work with scientists to create science communication strategies and develop policy to create consensus on the key facts.

scientists cannot deliver this certainty. The scientific pursuit, they argue, is contingent upon holding space for uncertainty. They understand this as a major issue in bridging the gap between science and policy. Many of my interviewees do believe this to be the case. In a section below, I describe the interaction between a scientist and policymaker in which dialogue broke down because the scientist could not provide the certainty desired by the policymaker. I also found from my research, however, that where there is less consensus and the facts are relatively unstable, it is scientists, not publics and policymakers, who were far more concerned about uncertainty. My scientist interviewees think it is too early to bring neuroscience into policy discussions. Too much is still uncertain, datasets are too small, and mechanisms have not been pinpointed. At this stage in the knowledge production process, the level of uncertainty about the basic premises involved is simply too high. Rather than being a natural part of scientific inquiry, I argue that this high level of uncertainty makes scientists much more reticent to recommend policy. They characterize policymakers as being too eager to build new forms of governance around these nascent knowledge claims. It appears there are different types of uncertainty at work. The first type of uncertainty, which Bradshaw and Borchers identify, is a more ontological point issue in which researchers understand scientific inquiry as innately and necessarily uncertain because trying to know the world is a formidable task. In this sense, nothing is truly certain and there is no true proof that can guide policy. I argue for a second type of uncertainty – one that exists when scientists believe the knowledge and theories are incomplete, and require more study. This second type is unacceptable and risks getting the very basic points wrong – it can and should be mitigated through further research. This kind of uncertainty may be typical in relatively young fields or subfields of study. Different policy-engaged actors describe, and place blame for, the gap in different ways.

The question for scientists involved in policy often regards how much uncertainty is acceptable, and how much nuance can be erased for purposes of policymaking or communication to the public. For the purposes of policy, it is clear for scientists that there must be a degree of "appropriate simplification" (Hilgartner 1990). Policymakers tend to believe that scientists are uncomfortable with popularization, and want to include all of the details, ones they believe are extraneous. All of the above may be true, but I found that here, in this young field that is so closely connected to potential policy outcomes, scientists I encountered were not worried about simplification, rather, most were worried about getting the basic facts right. In the example of some of my neuroscientists interviewees, they worry about correctly characterizing the brain regions that are affected by socioeconomic status, and then they want to theorize, hypothesize, and test the causal mechanisms involved. They want to ensure that the simplification – which they know is necessary to produce policy and inform the public – is based on knowledge they believe to be genuine. While many scientists are concerned with enacting these kinds of policy, there are plenty of scientists more directly involved in creating neuroscience-based policy. Through this study, I have found that not all scientists share the same views about the same data, ideas, and polices. It is also the case that scientists are reticent about certain aspects of neuroscience making it into policy than others. Two of my respondents, postdoctoral fellow Laurie and lab manager Jordyn, believe there is enough evidence from neuroscience to make changes to early education policy, but not for the widespread use of brain imaging in the courts. Even further, scientists' beliefs about the use of neuroscience are at times inconsistent. The same scientists who worry about prematurely enacting policy on the basis of preliminary findings also express (perhaps contradictory) beliefs that neuroscience rhetoric can be used to legitimate things we know to be true. For instance, they believe that neuroscience can bolster epidemiological and

sociological research on the negative effects of poverty on children's wellbeing and academic achievement. In their eyes, using neuroscience as a persuasive tool in policy is acceptable in some situations and not in others.

Nonetheless, the push to get science into policy creates anxiety that policy is not truly evidence-based; they may argue, as neuroscientist John Bruer and anthropologist Joseph Dumit do, that the neuroscience underlying these policies is more akin to folk belief than technical research. Scientists perceive that much of the neuroscience invoked in policy discussions is a distortion of genuine knowledge that they are trying to produce. Additionally, by their own admission, they do not possess the necessary policy and lawmaking expertise. One scientist I interviewed, Sean, recognizes the desire to have an impact on policy, effect social change, and generally do good, but he is in a bind. He cannot move beyond his data without feeling he has damaged his scientific credibility.

> We are at that gap. Policy people say we want to have science-informed policy. Neuroscience is real, the brain is really there, it motivates people. We want to have healthcare and child welfare and education policies that are taking into account things that we're learning about brain science. The brain scientists are saying we might not be there yet at the point where we feel comfortable telling you that you should legislate something based on the stuff. (Interview Sean)

This discomfort is not merely about scientific credibility. It stems from serious reservations about resulting policy. Sean discussed the rather embarrassing case of a Georgia governor enacting policy based on the so-called Mozart Effect. Using (now discredited) evidence that infants' intellect can be improved by listening to classical music, the governor ensured that every newborn received a classical recording. Sean argues that this was a fundamental misunderstanding of the neuroscience at the time and a complete waste of resources. He argues, "people like me in the neurosciences were thinking, make sure they get milk. Get them food." It is not only credibility that is at stake. This is also a matter of good

policymaking, especially getting needy children the resources they truly need. Prematurely using neuroscience to create new policies around childcare may result in embarrassing and wasteful use of scarce resources. Enacting certain neuroscience-based policies means that other kinds of fundamental policies, for example, adequate nutrition, are left off the list of priorities. What results is a decrease in the credibility of neuroscience and early childhood policy, especially from the perspective of the public. And most significantly, children's basic needs may not be met in favor of implementing what was thought of, in this example, as cutting-edge neuroscience.

Scientists I interviewed recognize the tension between certainty on the one hand and action on the other. A graduate student in neuroscience with a specialization in policy had similar worries about pulling neuroscience evidence into policy. Speaking of its use in law and the courts, he says "we don't want to institutionalize a form of evidence that isn't ready, a standard that will be changing all the time. But at the same time, if you are interested in optimizing current policy, it's this balance" (Interview Jack). Another graduate I spoke to was similarly tentative about the role of neuroscience in policymaking. Despite her strong desire to increase the use and understanding of scientific knowledge by the public, especially among marginalized populations, she is reticent to make big claims about what neuroscience says, especially about contentious issues like education and in high stakes settings like courts. She, too, is receiving graduate training in policy; it is her explicit aim is to bring neuroscience and policy together. Nonetheless, she believes bringing science to the public and policy is fraught if the data is "not there yet." We had the following exchange after I asked her about the potential recommendations and interventions:

> Aaliyah: I think right now I don't really know. I don't think the science is really there yet to make a recommendation, but there's also the problem that science is never one hundred percent certain, so you're going to have to act, especially

> when you're making laws. But I think at this point I would not feel comfortable making recommendations.
>
> KT: I've heard that today. I've heard that a couple of times before. People say the science isn't there yet. Do you mean that you don't have good enough equipment yet, or you haven't collected enough data? What does that mean?
>
> Aaliyah: I think like it means that, I don't know, you know neuroscience is kind of a younger field. We're just starting to explore how the brain works and I feel like sometimes we have no clue compared to all the other things we know. […] Eventually you have to but I think right now there's not enough conclusive stuff to really base [policy on]. (Interview Aaliyah)

Neuroscientists feel immense responsibility in bringing science to policy, and want to get both the science and its translation to policy right. My interviewees advocated a cautious and conservative approach despite their commitments to science-based policymaking. Many scientists are not certain enough about their findings to recommend policy, but they also recognize its significance, especially given its potential to transform the lives of the most vulnerable. Perhaps because of this significance, they want to move carefully. Those on the research end of the spectrum are most concerned with producing the most credible scientific knowledge, and not sullying it with what are, in their view, untrustworthy and unverified discussions of the implications of the work, which often strike an alarmist tone. Those in government have little use for preliminary findings that cannot be transformed into concrete solutions. For many serious and intellectually conservative scientists, those whose research may often be taken up, SDN discourse may ultimately be problematic for the state of the field, public understanding of science, and the future of policy discussions.

Many of my interlocutors who are more active in the policy world, be they scientists, science communication experts, doctors, or those working directly with clients, like social workers, emphasize bridging that gap with existing data, claiming that there is sufficient evidence to bring insights to bear on the policymaking. In fact, many will claim that we have

a moral responsibility to produce policies despite incomplete knowledge. A PhD/MD and I had this interchange about the importance of acting on knowledge that we have:

> KT: One last thing I guess I'll ask is there are some that say you know we are too early in the research to create policy and…
>
> John: That's clearly false.
>
> KT: Go on.
>
> John: There are never going to be [clear answers], at the end of the research, so what then are you waiting for? I think it's true to say it's always a challenge to know what the policy issues are, so I think that's true, but I don't think it has anything to do with being at the beginning or the end. That's always going to be, it's never going to go away. It's not like there's this golden dawn that's going to happen. It's always part of our human responsibility to figure out what the policy and implications are. That's a challenge, we need to take it on, we cannot shirk it. There's no better time. Do it now. Sure we'll make some mistakes because we always do but there's no right time. That's sort of nonsense. (Interview John)

As someone who works with patients daily, this interviewee emphasized knowledge that was good enough, and things that we already know from existing research and experience with patients. Policy building based on incomplete knowledge is considered far better than not acting; John disagrees that the knowledge we have is incomplete. He thinks that it is morally suspect to put off policy in favor of more and more data collection. These sentiments are similar to those espoused by Brian Campbell (1995) and Michelle Murphy (2006), who both suggest that claims to uncertainty are politics by other means. Claiming that the science is uncertain and therefore action cannot be taken is a method to forestall action, often in arenas that are politically charged like environmental regulation. In this case, however, those concerned with uncertainty are the scientists I spoke with. Their concerns about the evidence are about bringing the best evidence to bear on social problems, but they are primarily related to the integrity of the scientific enterprise, and perhaps its long term credibility and power to make policy, more than anything else.

I want to suggest that for the case of SDN both of these positions – a desire for more certainty and a call for action despite incomplete knowledge – are reasonable. Critics of policies that claim to bring neuroscience evidence into discussions of social issues are not being stubborn in their criticism. Yet, other actors do have reasonable expectations that scientific knowledge should not stay within the confines of the ivory tower. Policy-engaged actors all agree that at some point, policy must be made, but at which point, with whose authority, and with which facts? The line is not so easily drawn. The science-policy relationship is about just these disagreements and legitimate concerns. These are fundamentally arguments about what constitutes good science, good policy, and a robust science-policy hybrid, where social and scientific concerns are inextricably and productively woven together.

Those who try to institute science-based policy, like the organizations and practitioners I speak of, are in the tough position of trying to make policy with scientific evidence that is at considered fairly accurate and yet also incomplete. For practitioners and those who think of themselves as gap-bridgers, what matters is the usefulness of SDN discourses since complete knowledge and clarity are thought impossible. The usefulness of SDN discourse would lie in its ability to give some guidance on how to change clinical practice, for instance. Perhaps some agree that complete knowledge is never possible, but as I have said above, for many it is just too soon. The stakes are different, and the sense of what is an acceptable risk and what is prioritized, action now or truer later, varies across these different actors. In chapters 4 and 5, I will discuss advocacy and policy-engaged science in greater detail. I cover how new narratives of childhood development occur, and how negotiations around uncertainty, usefulness, and good science unfold.

Chapter 4. Narratives of Justification: Discourses of Neuroscience, Economics, and Morality Coalesce

Over the course of my fieldwork, I have witnessed how logics of science, economics, and morality come together in debates about children's brains to usher in a new discourse of how we should understand and govern childhood development. In this chapter, I ask how narratives of childhood brain development have become so compelling in policy, popular, and scientific discussions. Key stakeholders use scientific evidence to draw attention to social problems in new ways; they craft narratives that can change the nature of these important discussions, and ultimately have an impact on governance, and if we take the research seriously, children's experience and brain development.

How does child brain development become an issue worthy of greater public and political attention? The social constructivist literature on social problems tells us that social problems are not objective realities; rather than straightforwardly existing, social problems are produced through active, collective negotiation (Blumer 1971, Spector and Kitsuse 1973) and must compete for scarce public and political attention (Hilgartner and Bosk 1988).[17] This is true for the social problems featured in this dissertation, like inequality and trauma, which are theorized to affect child brain development. Further, less than optimal brain development is thought to produce other social problems like poor academic performance, unemployment, addiction, criminality, and so on. To make sense of how these narratives about social problems develop, coalesce, become authoritative, and produce effects in practice, I look to Maarten Hajer's (1993) discussion of discourse and discourse coalitions. I am indebted to Foucauldian theories and methods concerning language and discourse, but

[17] For critique of the social constructivist approach to social problems, see Woolgar and Pawluch (1985).

employ Hajer in this analysis to better account for the totality of discursive effects. The strength of his perspective lies in its ability to make sense of the social practices that are intimately intertwined with the discursive – practices that simultaneously produce and are produced by said discourse. Hajer argues that the concept he terms a "discourse coalition" is potentially useful for its "ways of combining the analysis of the discursive production of reality with the analysis of the (extradiscursive) social practices from which social constructs emerge and in which the actors that make these statements engage" (45). In this chapter, then, I make sense of how arguments about childhood development and social problems – discourses that seem on first glance to be natural and obvious – are built by combining multiple forms of expertise and argument, and the social contexts which they emerge from and enter into.

I argue that this narrative of childhood brain development is unique and evocative not only because of the controversies intrinsic to discussions of biological evidence around the self and the social, but also because it revolves around the intersection of three topics. In the discussions around childhood brain development I see the convergence of rhetorics of justification around: 1) neuroscience; 2) economics; and 3) childhood and morality. These forms of evidence are politically appealing and scientifically credible. Together, these narratives make a compelling argument for new forms of policy, action, and governance. The convergence or triangulation of these forms of explanation and evidence grants greater credibility and legitimacy to knowledge claims about the developing brain. The three kinds of discourses – scientific, economic, and moral – are mutually confirming. Put in Hajer's terms, scientific, economic, and moral logics have discursive affinity, which means that "arguments may vary in origin, but still have a similar way of conceptualizing the world" (47). This is similar to Lakoff and Johnson's (1980) argument that metaphors may be coherent without

necessarily being consistent; this means that they can generally fit together and support similar conclusions (94). Lakoff and Johnson's metaphors, like Hajer's storylines, play an important role in constituting the world that we inhabit, and how we act on it. It is also worth noting that there are also ways in which the discourses challenge each other. Interested stakeholders often pull on all of these discourses simultaneously and seamlessly when advocating for courses of action in the realm of childhood development. What are these claims, how do they come together, and how are they ultimately naturalized? How do scientific, economic, and moral discourses coalesce to create a convincing narrative about childhood and brain development, especially where decades of behavioral and sociological evidence appear to have fallen short?[18]

I begin by discussing discourse in greater detail. I also briefly discuss various actors' desires to structure social problems and scientific solutions in particular ways. Their political objectives lead them to structure rhetoric "to impose their view of reality on others, suggest certain social positions and practices, and criticize alternative social arrangements" (Hajer 1993). In other words, we see how they deploy scientific evidence to create the kinds of social structures, policies, and individuals they believe in. I then move to discussion of the three discourses in greater detail. First, I analyze the popularity of the neuroscience discourse to understand how it has become a unique tool for studying social structure and social problems. Though it seems as if neuroscience merely adds a veneer of scientific legitimacy to well-worn claims, researchers hold a more sophisticated view, and promote the use of neuroscience for multiple reasons. While they do maintain that discussions of the brain and

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[18] Of course, these converging scientific, economic, and ethical claims are built upon decades old research. Part of the power of the scientific research is that many are convinced that it corroborates claims from the social sciences. The fact that these analyses provide evidence to confirm the social research leads to their greater significance, especially for creating policy.

neuroscience are popular (perhaps problematically so), they also believe that neuroscience accounts for phenomena better because of the ability it grants researchers to theorize and test the biological substrate, that is, the mechanisms that underlie our physiology, psychology, and behavior. Next, I discuss how knowledge from economics comes in to these discussions, and makes the recommendations from neuroscience not only plausible but a matter of good economics and governance. In the last part of this section, I analyze the role of discourses around childhood. This framework understands social structure and social problems as emerging from the dynamic intersection of biology and society, self and society. Just as the research areas come together to make more credible and powerful claims, the neuroscience itself aims to capture many aspects of life and analysis through this potentially dichotomy disrupting perspective. I try to capture this overall trend throughout this dissertation. I conclude by discussing how these discourses are intertwined with activism.

Framing Problems and Politics

Most scholars of discourse, following Michel Foucault, understand discourse as producing the very things – people and phenomena – they attempt to explain. Phillips and Hardy (2002) use the following definition: "a discourse [is] an interrelated set of texts, and the practices of their production, dissemination, and reception, that brings an object into being" (3). They also maintain that "language constructs phenomena" rather than represents it (7). Further, discourse puts limits on what is possible and impossible, setting the parameters of what can be said and done, and which lives and subjectivities can be lived. Jorgensen and Phillips (2002) touch on this point when they propose that discourses privilege certain understandings of reality, and therefore "constitute subjects and objects in particular ways, create boundaries between the true and the false, and make certain types of action relevant and others unthinkable" (145). These analysts understand discourse as having

a real effect on lived experience; it is not merely text – it bursts out of these strictures into the world. Jean Carabine's (2001) definition of discourse also emphasizes the productive nature of discourse but also insists upon its interaction with the social; here discourse consists "of groups of related statements which cohere in some way to produce both meanings and effects in the real world" (268). This emphasis on the "real world" reminds analysts that a singular focus on language and texts is insufficient. The effects and uptake of the discourses across expert and non-expert groups are of paramount importance for a comprehensive and nuanced analysis. This leads me to ask what kinds (cf. Hacking 2002) of social problems, solutions, bodies, children, policies, and societies are made possible through a discourse coalition of neuroscience, economics, and morality? Which kinds become unthinkable? Scientific discourses about brains and childhood development burst out of the lab and off the page to impact how we think about a number of issues, how we govern, and the kinds of lives children lead. This discourse coalition is poised to constitute the world we live in, and our behavior.

While discourse analysis often entails a deep reading of texts, my analysis zooms out to understand how multiple discourses and expert groups interact to build a cohesive narrative about large-scale social issues like inequality, education, and criminality. I also illustrate how institutions incorporate the discourse of childhood brain development into their practices. Hajer terms these emergent narratives "story lines." He notes that a

> discourse coalition approach suggests that once a new discourse is formulated, it will produce story lines on specific problems employing the conceptual machinery of the new discourse […]. A discourse coalition is thus the ensemble of a set of story lines, the actors that utter these story lines, and the practices that conform to these storylines, all organized around a discourse

I will use the terms narrative and story line interchangeably from here on out. A story line or narrative about childhood brain development that combines logics of good neuroscience,

sound economics, and our moral responsibility to children reshapes our collective beliefs about how to best build a just and healthy society. These narratives also provide justification for acting and acting quickly. Policymakers and scientists present these story lines to a variety of audiences. The narrative provides justification to act – to change policies and practices despite desires to maintain the status quo and the expense and effort of making change. As I will show, these discourses do not have to be identical, but they are most powerful when they fit together, and support each other in some broad sense. Hajer's research on acid rain suggests that people making sense of complex problems combine discourses of science, economics, engineering, and politics. I also see scientific and economic discourses as essential to the brain narrative. This does not suggest the similarity of the cases, rather, it shows the ubiquity of scientific and economic logic in the U.S. and Canada.

Scientific evidence, in this case research from economics and neuroscience, proves a strong discourse to rally around. According to Hajer, scientific evidence "dominates the political debate and sets limits to the range of solutions that are considered" (46). Scientific facts do not just emerge from the world, however. They do not represent reality unproblematically. As Löwy (1988) so aptly puts it, scientific facts "do not exist 'out there' in nature waiting to be discovered by objective and interchangeable observers" (135). In producing scientific discourse – facts, techniques, representations of the brain – scientists actively shape the world they "discover."

Facts about children's brains do not just materialize on the scientific and policy scene. Advocates must bring these ideas into being and to the right audiences. The expert groups I worked with were explicitly concerned with bringing a scientific understanding of social problems into being. In fact, as will be seen in chapter 5, the organizations involved in championing this cause readily admit that they are trying to create narratives that reframe the

issues in scientific terms. Part of their success in changing discourses and narratives rests upon that ability to bring a scientific, and therefore legitimate, perspective on these issues. Behind this curtain of objectivity, however, lay other social and political goals, as they ultimately champion collective and social solutions to problems. The narratives they build challenge existing individualist discourses, and they do so by hooking into values of objectivity, economic growth and efficiency, and morality.[19] Scientists and policymakers I interviewed understand the reality of trauma and social inequality in particular ways, and want to shape how others see the world.

Building a Narrative for the Neuroscience of Social Problems

Neuroscience

Neuroscience discourse is of foremost importance in highlighting and framing childhood development and its links to social problems. When I encountered this scientific research, in fact, my first question was: why neuroscience? Some of the existing social science literature on neuroscience (Dumit 2004, Joyce 2008, Vidal 2009) suggests to me that neuroscience is powerful because it is scientifically credible, produces meaningful visual representations of data, and gives us the sense that we can access our innermost selves. Research about the brain is evocative at least partially because studying it is a proxy for scientific analysis of something far less tangible: the self. But why are neuroscience and biology used to answer these questions about social problems when there has already been such extensive study of poverty and development by sociologists, anthropologists,

[19] Despite the fact that these narratives challenge dominant discourses, they at once emerge from specific kinds of perspectives about which research and ideas can best account for the world and inform governance. Biomedical and economic research privilege a certain type of view and structure the world in specific ways. I expand this dual tendency to reinforce yet also disrupt dominant discourses more thoroughly in chapter 6.

psychologists, and other humanists and social scientists? Indeed, what drew me to the field was what I thought was an odd marriage: neuroscience and poverty. This pairing is unusual given the fact that biology is often critiqued for not adequately (or at all) accounting for social life. Basic claims about poverty and other social ills seem common knowledge; most will acknowledge that trauma and poverty are not positive experiences, and many with even a brief acquaintance with the public health literature know that poverty is associated with poor mental, emotional, and physical health (cf. Krieger et al. 1993, Phelan, Link, and Tehranifar 2010). My first hypothesis was that bringing neuroscience into these debates adds a patina of scientific credibility and objectivity to a politically charged arena of social science. Social science, unlike the ideal of laboratory science, has a reputation of being "soft," unscientific, unreliable, and fraught with subjective beliefs of the researchers. So, is this merely a matter of a more credible, scientific field coming in to the policy fray to make these previous studies from the soft sciences more credible? Does neuroscience offer scientific confirmation of "less scientific" claims? Scientific evidence does occupy a privileged position in our society, and claims of this nature are particularly powerful forms of knowledge. Though my neuroscientist interviewees' rationale for using neuroscience in policy is primarily scientific, which I touch on below, they do admit that neuroscience has immense rhetorical power. Puzzled one graduate student, "it seems kind of ridiculous, like why does talking about the brain make it more real" (Interview Violet)? This kind of refrain was typical of my interviewees. They were well aware that neuroscience is not necessary for studying and addressing social problems, but they were willing to use it for these purposes. Perhaps evidence from neuroscience is not necessary to prove that poverty is a problem, but for better and worse, it does make poverty "real." Or as another interviewee put it when discussing the power of fMRI, "a neuro image is worth a thousand words" (Interview

Wanda). I maintain, and my interviewees agree, that neuroscience carries enormous clout. And as I argue throughout this dissertation, these scientists are willing to harness this power strategically to advocate for social change. In my discussions with neuroscientists, I found that they believe that their work offers something beyond mere confirmation of contested and politically charged claims taken from the so-called soft sciences.

Scientists use this neuroscience research because they believe it produces excellent scientific knowledge, particularly about biological mechanisms. Neuroscience, from the perspective of researchers, does add evidence both unique and significant. Though the participants I interacted with at the Alberta Family Wellness Initiative neuroscience-based policy symposia series thought of it as slightly different packaging for old claims from psychology and sociology, scientists and many policymakers understand this evidence as having a fundamentally different character and meaning. With these scientific studies, researchers hope to hone in on causality and understand the phenomenon in its detail, and as such, they value neuroscience and genetics for offering information about mechanism and biomarkers. This kind of evidence tells them how things happen; questions of causality matter because it lets scientists posit how these mechanisms might possibly be mediated. They argue that this kind of biological evidence better pinpoints who is at risk, and which interventions they should seek. Of course, the entrance of neuroscience into this research realm is an example of the increasing scientization and biomedicalization of life, where scientific modes of understanding reality are prized above all others (cf. Clarke et al. 2009, Conrad 1992, Rose 2007, Zola 1976). The scientists in question would have no qualms admitting that they believe that biological, quantitative study of these phenomena produces the most valuable and valid knowledge. This is the most important and credible type of evidence, from their perspectives.

Neuroscience discourse is used strategically by scientists who are committed to social justice and economic equality; they employ evidence from neuroscience because they know how powerful and popular brain research is, and that it is imminently useful for improving not only the health of an individual but of a society. Despite this strategic use, they maintain that their rationale for using neuroscience is primarily scientific. In such a way, they can retain their ideals for scientific objectivity and social justice simultaneously. This is essential because it allows them to uphold their most dearly held scientific values, while also satisfying the questions and goals they had when they entered into this work. It permits them to interrogate boundaries between self and other, biology and society, nature and nurture, and offer up a more holistic – and importantly, complete – view of the human in his/her environment. The goals here are epistemological as well as political, and it is likely that they cannot be disentangled. My neuroscientist interviewees hold complex ontologies of brain, self, and society in place – ideas that have been unorthodox and often difficult to prove with certainty. Their work is concerned with measuring society, the social, the experiential, and the political in some sense, and the researchers cannot help but be invested in the social and political ramifications of the work. They recognize that we are not just brains in vats; though they privilege an arguably neuro determinist view of the self, they recognize the deep significance of the fact that those brains inhabit bodies, and that those bodies live in societies. This shapes our brains and who we become. Significantly, this research and its implications enable researchers to make sense of the sociopolitical without perceiving themselves as falling into subjective styles of qualitative analysis, thus maintaining discourses of objectivity and credibility. From my interview data, I found that my interviewees simultaneously argued for the strategic, yet objective, use of neuroscience. Because they hold

that these knowledge claims emerge from objective, scientific analyses, actors deem it acceptable and completely appropriate to use them instrumentally.

When I asked one graduate student about why she chose to study neuroscience when she was most passionate about social issues like homelessness, she told me the following: "I was interested in social issues, but I was also interested in hard sciences, and I felt that neuroscience, cognitive neuroscience, was a really excellent way to take a harder science, more mathematical approach to understanding these issues" (Interview Krystin). I pushed further, asking her why a hard science background is appealing and useful to her in analyzing something like homelessness. She discusses another social issue, suicide, to explain how neuroscience can contribute to practical solutions in the clinic. She notes,

> it was striking to me how, for a lot of these more social issues, there aren't any good analytical tools to access which kids are going to be at higher risk, [or] who might benefit from specific medications. How do you know whether to hospitalize someone or not when they display symptoms that a lot of people display? (Interview Krystin)

She understands suicide as an important social issue, but she ostensibly frames the problem in terms of individual risk. This kind of scientific research on social problems is relatively novel, as much of the research on poverty and social problems does not use individual, biological measures. These neuroscience studies measure the individual (her brain) to access information about the social. Embedded within the social developmental neuroscience (SDN) discourse are discourses about risk, biological and neurological mechanism, measurement, and diagnosis. This narrative holds that a problem can be concretized and measured without issue. Yet, in practice and in sociological analysis, it is not so clear that one can delimit and assess the entire constellation of variables that make up a phenomenon. My neuroscientist interviewees' discursive construction of social problems maintains the view that problems can be easily broken down into their constituent parts and studied

systematically. Further, it suggests that the deeper one delves into the individual, preferably to the molecular level, the better the knowledge (cf. Rose 2007). Research on socioeconomic status and the brain, for instance, cuts up the problems into discrete parts: the researchers believe social problems are rooted in differences in cognitive ability; the cerebral cortex is where they locate cognitive ability; cerebral cortex development is measured through cortical volume, which is taken from fMRI imagery; and researchers have found a difference in cortical volume across socioeconomic status. Their ultimate aim to is isolate and understand the molecular mechanisms that cause cortical volume to differ across socioeconomic status, which they believe is responsible for linking body and society.

Krystin sees neuroscience adding value in the clinic by providing analytic tools to further elucidate risk. She understands neuroscience as powerful in its ability to pinpoint with biological certainty who is truly at risk, and by extension, receives intervention and care. Accurate risk assessment is especially important given the challenge of distributing scarce funds: "we've got limited money [these kinds of tools] can allow for better allocation of funding resources." Note here that scientific and economic discourses reinforce each other. Krystin claims that this kind of work has the same clinical potential as other technologies measuring physiological responses: "in the medical field, when you do an ECG on someone's heart, [you] get this information about what their actual risk is based on a biological indicator you can measure on an individual." In her view, this is ideal, and the promise of neuroscience is "integrating these biological techniques into clinical decisions" in the near future. Risk of heart attack and risk of suicide are, from her perspective, similar kinds of risk that can be read in the body and brain, and clearly assessed through technologies. Further, this kind of evidence takes the onus off of clinicians, who have different levels of expertise and whose decision-making is "individual" and "idiosyncratic."

Biological evidence, from her perspective, is an essential component of making care and intervention effective, efficient, and rational. What was interesting about her view was that she positioned evidence-based interventions against what she understood as top-down expertise more than once in our conversation. For her, an evidence-based approach is more grounded and in touch with lived experience, whereas expertise is potentially rigid, disconnected, and implemented from on high. It is worth noting that she and other scientists tend to frame social problems in biomedical terms, or in the least, their perspective leads them to prioritize biomedical factors, measures, and outcomes. This makes sense since these are the factors they have been trained to notice and tackle. Despite this biomedical lens, these scientists still value interventions at what we might call the social level – they advocate for increased funding for social programs rather than clinical intervention into the body itself.

Some of my interviewees are hopeful that neuroscience will be able to provide evidence of the effects of adversity and experience in the brain before behavioral changes are even detectable. Early intervention and prevention is also essential in this area of work; since children go through critical or sensitive periods of brain development, early detection is invaluable. Again, scientific discourses are intertwined with those of risk and prevention. Argues one of my interviewees, "there are people who ask, what is the benefit of studying the brain itself rather than simply behavior, but I would answer that brain changes are often detectable prior to behavioral changes" (Nicole, follow-up email, May 2014). Another psychologist I interviewed said, even in spite of her ambivalence about the hype surrounding neuroscience, that neuroscience offers insights about the phenomenon that are extremely useful. This researcher notes, "the thing we're really keen to study, everybody is, is whether the prefrontal cortex is the canary in the coal mine" (Interview Helen). The hope is that

neuroscience will provide the best, most precise tools to understand which children are at risk.

The most important contribution of neuroscience, from the perspective of my interlocutors, is evidence of mechanism and causality. In the field of socioeconomic status and neuroscience, the research has thus far been descriptive, and future research will focus on ascertaining mechanism. One interviewee provided a helpful example of how imaging technology contributes to our understanding of mechanism and causality. When I spoke to Neville, a lab manager, he had a useful explanation for why neuroscience, and imaging technology in particular, matters. Neville met with me to teach me about major methods in neuroscience, especially functional magnetic resonance imaging (fMRI). As a lab manager, a major portion of his work is managing fMRI studies. Despite his discomfort with fMRI's dominance, Neville did maintain the importance and significance of fMRI research.[20] In research on aging, he offered, behavioral studies tell us only that aging causes cognitive decline. Behavioral studies can only describe that relationship in a general way, but cannot explain why and how that cognitive decline occurs. Neville used the example of baking a cake to explain it to me. Behavioral studies show us the beginning points and the end points, the raw ingredients and the finished cake, respectively. What the behavioral studies miss are all the steps in between that explain how that process occurred. Only knowing the starting point and what the finished product looks like give us very little information – it would be difficult to bake a cake or know how a cake is made from just this data. Taking his metaphor further, when faced with a less than ideal endpoint – let's say a cake with a displeasing texture and taste – the snapshots of beginning and end would not tell us where our baker has

[20] *Nota Bene*, it is very common for researchers in neuroscience who use imaging technologies to be highly critical and self-reflexive about the use of this technology.

gone wrong. Perhaps the baker misread the recipe and added too little sugar, but it is just as likely that another aspect of this complex process failed – ingredients, techniques, or temperature. Neville maintains that fMRI is useful because it has the potential to show us all the steps. Likening biological processes to baking a cake further makes these processes discrete, and emphasizes the ability of neuroscience to provide a direct look at the causal chain of events. For these neuroscientists, knowledge of the process in detail is essential to explaining phenomena, and for later reshaping those processes to therapeutic effect. Knowing that aging causes cognitive decline is all well and good, but it is not enough for these scientists.

Let's take the example of neuroscience and poverty. Evidence from IQ and psychological testing suggests a correlation between socioeconomic status and cognitive function, whereas current neuroscience uses imaging techniques to more clearly describe that correlation and the brain systems involved. Studies incorporating socioeconomic status are fraught; cognitive function is overdetermined. Are we truly measuring socioeconomic status or something else, and are there other factors that we have not taken into account that influence cognitive ability? To get around these complex methodological and ontological issues, neuroscientists theorize processes at the molecular level. The hope is that in the future neuroscience methods will not only describe that relationship but also tell us about the causal mechanisms that link socioeconomic status to cognitive function. This is articulated well in a quote from a key publication:

> While classic academic milestones like school graduation can tell us broadly about global effects of socioeconomic disparities on achievement, we know in fact that 'achievement' is the complex output of multiple cognitive systems which are supported by different brain regions and networks. Thus, although classic measures of academic achievement must at some level reflect the function of the brain, they are relatively uninformative concerning perturbations in specific cognitive and neural processes. A cognitive neuroscience approach, in contrast, reflects the fact that different neural structures and circuits support the

> development of distinct cognitive and socio-emotional skills, improving our efforts to provide targeted educational interventions. (Noble et al. 2012)

Studies of mechanism do not merely offer scientists the opportunity and authority to speak about the truth of things, they are also practically important for any application of knowledge to practice. They believe that knowledge of mechanism allows for the understanding of significant biomarkers, and targeted intervention – programs, drugs, and manipulations. Almost every neuroscientist I spoke with discussed the value of understanding mechanisms in similar terms. Epidemiologists and other public health experts might balk at this insistence on mechanism. After all, we do not need to know the exact mechanisms underlying how lifestyle choices like smoking and poor nutrition affect health to know that policies encouraging smoking cessation and healthy nutrition benefit public health. Though the focus on mechanism may seem pedantic, my neuroscientist interviewees insist that evidence of mechanism is best, and believe they are paving the way for careful policy and practice.

Neuroscientists I interviewed believe that evidence of mechanism is most useful for understanding which aspects of the underlying biology can be altered to therapeutic effect, however, it is not insignificant that this then allows for testing those interventions. For one interviewee, this is where evidence from neuroscience is especially useful and unique – understanding the impact of social programs through measurable biological outcomes allows scientists to test interventions in a new way. This interviewee was particularly excited about the potential of this evidence because so few interventions are tested for their efficacy in the first place. Says Krystin, "[t]here are a lot of resources out there, but it can be confusing when they don't have an evidence base. […] Many programs are not evidence-based, and there's a lack of funding to collect data to make sure that they are doing what they are supposed to in any given situation." A growing number of medical professionals uphold

evidence-based medicine, based on modern biomedical study, especially the so-called gold standard of randomized controlled trials, as an essential intervention into medical practice. (Timmermans and Berg 2003). Neuroscience is thought to have the potential to inform evidence-based interventions. Testing allows scarce funds to be distributed to only those interventions proven efficacious by the standards and means of neuroscience. In our interview, Krystin discussed both biomedical and social interventions; the programs she is believes could benefit from testing are parenting classes, daycare, and housing support. A biomedical or scientific assessment all types of interventions is what she hopes for. Evidence-based policy, from the perspective of scientists I interviewed, must have a basis in scientific studies that speak to causal relationships, and they should provide evidence of mechanism. Neuroscience and neuroscientists make the case for "the neuro" as a "node of governance" by producing novel scientific insights and also offering up concrete, practical, and testable solutions to social problems. I use the phrase node of governance because the brain becomes just one more point in a network of potential targets for study and intervention with respect to poverty.

Of course, it should be noted that while neuroscience appears to offer clear and objective accounting of phenomena, it privileges reductionist, individualist, biomedical, and neurologically-determinist studies of the phenomena under investigation. What has emerged that is more surprising, however, is that neuroscientists and policymakers I spoke with do not necessarily advocate for biomedical, reductionist, and individualist types of interventions. They instead promote interventions that target the social environment. This suggests they hold a far less simplistic understanding of brain, self, and society than might be true of other researchers who uphold biomedical and reductionist perspectives and practices. A neurodeterminist lens may be far less determinist than I initially imagined. I expand upon

how these neuroscientists produce novel and intriguing discourses of brain, self, and society in chapter 6.

Economic Justification

Krystin's quote above about scarce funding illustrates that questions about risk assessment, mechanism, intervention, and testing occur in the context of dominant discourses of economic scarcity and cost-benefit analysis in governance. Discourses of economic feasibility and the economic health of a society are of almost equal importance to neuroscience discourse in the context of optimal child brain development. Economic discourse is what allows policies to be put into practice. Economists claim their field is more scientifically credible than fields like sociology; its relative credibility is clearly enhanced by the quantitative nature of the field. On the whole, discourses of neuroscience and economics are mutually supporting. Without the help of economic discourse, social developmental neuroscience discourse might not have as great an impact on governance. While scientific evidence may legitimate requests for funding, it does not offer any guarantees. One American health economist told me that it does not matter how effective an intervention is, if it is not cost-effective, it will not be implemented (Interview Kat). While Kat advances this claim as if it is a fact, her claim is actually a normative one about the necessity of economic evidence for policymaking. In their study of health economics discourse, Ashmore, Mulkay, and Pinch (1989) illustrate how economists persuade doctors to think in economic terms, and to see economics as an indispensable resource for medical decision-making. In the context of social developmental neuroscience, economists and policymakers have evidently convinced neuroscientists that concepts of scarcity and cost-benefit analysis should be central to the SDN narrative. So, even if the most definitive studies proved with absolute certainty the factors that negatively affect the brain, and the perfect interventions to target

these factors, it is not necessarily the case that these interventions will be carried out. Without political and economic support, neuroscience-based interventions are deemed infeasible. Thus, one of the most potent relationships I have seen emerge in this area is the one between neuroscience and economics. The credibility and feasibility of child development policy has been greatly increased by pulling in evidence from economics. Support of economic analyses, such as those from James Heckman who I discuss below, are essential for broad support and funding. These studies, of course, are themselves products of dominant values about individuality, rational choice, free markets, private property, and competition. The question is not can we improve children's brain architecture (and by extension, well-being); rather it is can we afford to improve children's brain architecture? Even further, economists and policymakers ask, is it a good investment to intervene on children's brains?

The most famous work in the economics of early childhood investment comes from James Heckman (2006), who won the Nobel Prize in economic sciences in 2000. He provides the most potent evidence that investing in early childhood is good for the well-being of not only children but for society on the whole. Heckman was cited by many of my interviewees in both our interviews and their scientific papers; his arguments have reached a wide audience in education, neuroscience, economics, and policy. My interviewees in both policy and research would bring up Heckman's ideas about early childhood investment often, asking me if I knew his work, and then giving me a brief overview of his major ideas. This suggests to me that these discourses have been effective in constituting a new story line about early childhood development. Involved actors have successfully disseminated these narratives across a number of audiences, including scientists, even those who were more skeptical about neuroscience policy. Interviewees would tell me that early childhood had an

excellent "ROI" (return on investment). One neuroscientist interviewee suggested that, "putting money into early childhood interventions is better than playing the stock market" (Interview Owen). Heckman argues that

> Investing in disadvantaged young children is a rare public policy initiative that promotes fairness and social justice and at the same time promotes productivity in the economy and in society at large. Early interventions targeted toward disadvantaged children have much higher returns than later interventions such as reduced pupil-teacher ratios, public job training, convict rehabilitation programs, tuition subsidies, or expenditure on police. At current levels of resources, society overinvests in remedial skill investments at later ages and underinvests in the early years. (Heckman 2006)

Above, Heckman first highlights the ethical imperative to invest in children, and makes clear that he values social justice and fairness. His argument becomes more attractive to my interviewees when he pairs ethical discourses with discussions of economic productivity. He makes these policies visible, and also positions them as a matter of good economic sense. Most importantly, he uses the language and analytic of investment, and argues for the better allocation of money already in use for social programs. By redirecting funding to better, more economically viable interventions, Heckman avoids calling for greater spending. I believe Heckman's work is undoubtedly political, yet, it is depoliticized through his use of "objective" economic measures. Just as science is always already situated and subjective, economic evidence is itself imbued with the social, political, and ethical. So, economic refrains may be as constraining as they are productive and effective; I want to flag that while using these data in such a way furthers our goals for social justice, unintended consequences may arise. As I noted above, capitalist values are built into economics, and we also see that smuggled into these "objective" documents are ethical and social discussions of criminality and community. We must remember then that economics, though used as a value-free arbiter, is not value-free.

Economic rationality also enters into these neuroscience discussions more formally, as developmental psychologists integrate economic variables into their experiments and even seek out research partnerships with economists. The collaborators design experiments to test the physiological, cognitive, and behavioral responses to changes in income. Here we see the integration of neuroscience and economics from the outset. One interviewee is particularly keen on these collaborations because he understands himself as measuring individual, biological inputs and outputs, while the economist "measures the environment" (Interview Sean). This proclamation from Sean is telling. Economics is thought to be the best method for understanding the totality of factors outside an individual. Put otherwise, Sean understands economics as measuring society. This researcher did not state it explicitly, but it is clear to me that he believes that interdisciplinarity of this sort makes his work more viable to funders and policymakers. Further, collaborating with powerful centers for economic and policy analysis no doubt improves the potential to disseminate knowledge and have an impact on policy.

Much of the neuroscience research I have detailed in this dissertation collects demographic data on its subjects. More and more, neuroscientists seek to manipulate economic variables in an experimental or quasi-experimental setting to pinpoint cause and effect relationships. At least one lab is planning a study using a new method called "income randomized controlled trials." Like other RCTs, these trials randomly assign families in the study to either an experimental group or control group. The control group receives a relatively small amount of money, while the experimental group receives a larger sum. I interviewed Jordyn, the lab manager helping design and run the income randomized controlled trial. They thought this would amount to $100 for the control group and $1000 for the experimental group, approximately the amount of the earned income tax credit

(Interview Jordyn). Their aim is to measure if and how an increase in income alone changes brain structure; fMRI scans of children are performed pre- and post-experimental manipulation. Knowledge gleaned from experimental and quantitative studies are again most highly valued. The randomized controlled trial, in particular, is considered the "Gold Standard" for evidence. As I will suggest in chapter 6, valorizing this kind of scientific research as one of few reliable sources of knowledge is highly consequential. Nevertheless, these kinds of RCTs do raise moral questions. If income RCTs do indeed provide compelling evidence that income itself makes a difference (rather than increasing funding for programming, for instance), it suggests what poor families need most is more money. What is our societal responsibility to families if scientists and economists find that some baseline of income is required for proper development? Here, a confluence of powerful evidence – brain scans, economics, and randomized controlled trials – is poised to change the way publics and policymakers think about improving disadvantaged children's lives, how we think about the creation and transmission of inequality, and even the basic social and economic organization of our society. And here we see where scientific and economic discourses might make new demands of us, hooking into discourses of morality.

I also saw other subtle relationships to economics during my fieldwork. During the neuroscience-based policy symposia series, organizers and participants often referred to the business community as a key stakeholder in the science-based policy arena. One group of participants targeted the Calgary business community as their object of knowledge transmission. They sought out links to the business community for two major reasons. First, they wanted to draw upon the significant resources of business community. Second, and most importantly in my view, they framed the business community as a major beneficiary of better early childhood policy. Because evidence from economists like Heckman suggests that

investments in early childhood produce smarter, more productive individuals, the business community has a vested interest in bringing these good consumers and workers into being. Today's children are tomorrow's employees. While the business community may indeed be interested in fairness, social justice, and children having great brains and great lives, it is also concerned with the bottom line. A more cynical reading might hold that business is primarily or solely concerned with economic considerations, and social justice is PR bonus.

"It is difficult to vilify a child"

Economic and neuroscience-based discourses have proven effective in changing the discussion about the developing brain. However, social developmental neuroscience narrative gains the most traction when it combines powerful scientific and economic justifications with the rhetoric of moral obligation. In this case, bringing calls to care for children grants new urgency and a sense of responsibility to science-based policy questions. While adults may be entreated to pull themselves up by their bootstraps and take individual responsibility for their circumstances, for most Americans and Canadians, this would be an absurd response to child poverty. In contemporary society, children are viewed as innocent,[21] and it is a priority for many governments to reduce child poverty, abuse, and hunger; taking care of children is seen as a basic responsibility. One of my interviewees suggests that childhood innocence is an important factor in these discourses. While it is easy and common to blame the victim for poverty or addiction, for instance, "it is difficult to vilify a child" (Interview Owen). Frustrated with the rugged individualist mentality so prevalent in

[21] A study titled "The Essence of Innocence: Consequences of Dehumanizing Black Children" (Goff et al. 2014) illustrates that not all children are presumed equally innocent. African American children, in particular boys, are perceived as less innocent than their peers, more responsible for their actions, and therefore are more likely the target of police violence. Since the children concerned in this work are often marginalized minorities this issue of differential innocence may prove significant in the future policy discussions.

American (and Canadian) society, an economist joked, "yes, even the infant" (Interview Kat) should pull itself up by its bootstraps. This image of the infant illustrates exactly how absurd an idea this is. Our reactions in these instances show how difficult it is to fit children into discourses of personal responsibility and neoliberal selfhood. Seeing how children challenge that economic and moral model illustrates to us the limits of such individualistic discourses of building and governing modern societies. Even if we understand children's parents as lazy, selfish, and unproductive, we tend to understand the children themselves as victims of circumstance. While parents can and should (under this logic) be rugged individualists, children cannot, and we admit that they require care and education by adults. In a context of sincerely held beliefs about our presumed equality and opportunity, it is essential to maintain children's ability to strive for the so-called "American Dream." While it is debated how exactly children should be educated and cared for, politicians of all stripes agree that children and childhood matter. Of course, structural racism and classism ensure that some children matter far more than others do in policy discussions.

Discourses about our ethical obligations to children proliferate. What results from them is less clear. My interviewees regularly told me that invocations of responsibility and childhood innocence have little clout in practice. Any interviewee working in policy reported again and again that referencing children is a powerful political and rhetorical tool, but that these pronouncements about the importance of children's care rarely results in increased funding and support. Said one, "lip service, look at what we actually do […] we all want to talk about how much we love kids, but if you look at policies, that is not clear" (Interview Wanda). Many argued that since children do not vote, they have very little political power. Add to this the fact that politicians are concerned with the short term (Interview Daniel),

and concerns about child development – which are necessarily about the long term – fall by the wayside.

Knots of Discourse and Activism

In a world of cerebral subjectivity (Vidal 2009), invocations of "the neuro," tend to gain some publicity and traction. Discourses of neuroscience, alone, are not enough to produce effects in the so-called real world. When a discourse coalition forms, we witness the emergence of powerful narratives that have the capacity to frame which kinds of individuals and societies are possible. The discourse coalition I have described brings social issues of inequality and child development into the public in a novel and significant way. Neuroscience transforms existing discourses around early childhood development; in doing so, these issues can compete for scarce public and political attention. Neuroscience reinvigorates these discussions, and lends new credibility to the notion that we can and should do more for children in poverty and adversity. This reframes action on social problems, especially those related to childhood poverty and adversity, as something that society is responsible for, a necessity, economically and morally.

Neuroscience has been compelling for a number of reasons that I have detailed in this chapter, and across this dissertation. Changes in science-based policy do rely on both the popularity and credibility of neuroscience. Scientists' focus on objectivity and mechanism leads them to interventions for the clinic; they offer up practical solutions that are relatively straightforward and discrete, and can later be accounted for and empirically tested. This gives neuroscience the rationale and opportunity to try its hand at policy. It enters these conversations as an objective discourse, and is therefore seen as useful tool for assessing highly politicized social issues. It appears to depoliticize these policy conversations. Yet, I've noted that interested actors are also willing to use neuroscience evidence strategically to build

what they believe is a better world. I have argued that their epistemological and political goals for making sense of the biological and the social are inexorably linked. They believe that social and biological worlds cannot be disentangled from one another. A child's social experience, and the politics that produce that experience, become the material stuff of the brain. Economic evidence offers an additional form of accounting that also makes claims to objectivity. Invoking economic evidence, even more than scientific evidence I believe, is thus a kind of shorthand that allows us to sidestep discussions of ethics. Economic evidence offers one common view of what good, ethical policymaking looks like – achieving goals in a cost-effective and efficient way. Arguments about our moral obligation to children are not novel, nor are those targeting inequality or mass incarceration. Neuroscientists interested in social problems, especially those related to inequality and racism, built this area of research because of what they believed to be a moral obligation – I explore this further in chapter 6. They carried out the research with the hopes of bringing a neuroscience toolkit to these issues, and to ultimately shine a light on issues like poverty and trauma, even though most hold that poverty's negative effects on health are a matter of common sense. They realized that even when the issue is the very health and wellbeing of the youngest, most vulnerable members of our society, social change proves difficult. Moral arguments alone have not been able to produce the kinds of social action and policy necessary for all children to thrive. In my fieldwork and interviews, I have seen how these forms of justification become intertwined and mutually supportive. This discourse coalition positions action against inequality as economically viable, scientifically sound, and an ethical necessity. However, this coalition is only in its beginning stages, and its impact on policy is relatively small at this point. It is not yet clear if the lay public and more policymakers will be convinced by this framing of early childhood development discourses. In Alberta, Canada, the location of one

of my field sites, the Alberta Family Wellness Initiative has used this discourse coalition to great effect. It has disseminated this knowledge throughout its education, medical, and social work sectors, and instituted wider public awareness campaigns to emphasize the importance of early childhood brain development. They have put significant resources into addressing childhood adversity, and have created the Alberta's Social Policy Framework (Alberta Government 2013) that formalizes these discourses into governance. Will other provinces, states, and nations follow suit? It is not yet clear.

As these discourses have coalesced into a coherent narrative, it proves difficult to disentangle them, both practically and philosophically. I argue that neuroscientists, economists, and policymakers make arguments for childhood development based on both ethical considerations and scientific evidence, yet they emphasize the economic and neuroscientific to support those claims. Or, they may avoid the normative and political dimensions altogether if that is what the context demands. When I asked my neuroscientist interviewees if they were political, they often refused such a label. They may allow that moral and political interests informed their interests in the area, but typically maintain that these interests were built through unbiased research rather than any sincerely held political belief. Scientific language and analyses depoliticize these desires for social justice, and in such a way an economizing and scientizing discourse has great clout. My interviewees are savvy, and understand that power of neuroscience to produce apolitical justifications for actions usually associated with social justice and activism. Even if they do foreground themselves as progressives, they also maintained to me that the research was objective. They told me that, in principle, results that point them in a different policy direction could always challenge their seemingly "liberal" and "moral" arguments.

While my subjects would likely eschew the activist label, I believe that there is space to suggest that these scientific forms of speaking for children, who have relatively little power, is a kind of activism. Following Joan Donovan (2016), I suggest that the use of science for the purposes of social justice may constitute what Gabriella Coleman calls "weapons of the geek" (2017). Donovan argues that data production is another form of activism. Using statistical data as a tactic is one of the "many ways to fight and win." Science and economics here are used to advocate for children in new ways; though I consider this narrative a new common sense (cf. Geertz 1975), my interviewees and I both understand the work (at least in part) as new proof of what we have known all along, namely that poverty, inequality, and trauma hurt individuals and societies over the long term. What I find most significant is that these economic and neuroscience data are used to suggest that we have an ethical obligation to helping children, and that this must be accomplished by undermining the dominant rational, individualist discourse. Which kinds, to use Hacking's (2002) phrasing, emerge? It is not abundantly clear, but perhaps it suggests a society that takes more social responsibility for the experiences and bodies of its members. In the least, it could mean that the notion of a rational, neoliberal subject is challenged by an assemblage of biological, economic, and moral concerns.

As I have stated above, the emergence of a narrative that combine logics of neuroscience, economics and morality has resulted in policy change in Alberta, Canada. It is not clear if there will be broad implementation of these policies in other provinces and nations. Nor is it clear what the long-term impact of this new framing is on addressing social problems. In the next chapter, I turn to a specific case that illustrates how neuroscience-based discourses and policies are being put into practice. In chapter 6, I look more explicitly at the stakes of justifying policy in such ways, and the kinds of controversies have emerged.

Chapter 5. Crafting Neuroscience into Policy

During my participant observation at neuroscience-based symposia series bringing together scientists, practitioners, policymakers, and philanthropists, I witnessed how new science-based discourses come into being. In this chapter, I describe how one specific neuroscience narrative or story line (Hajer 1993) takes shape. The narrative that emerges is one that relies on the most powerful forms of evidence and also keys into dearly held values about our moral responsibility to children. In chapter 4, I suggested that neuroscience, economics, and morality have discursive affinity, and are used together by advocates to encourage new modes of governance with respect to early childhood development. By using these potent forms of evidence and argument, policy-engaged actors try to change public perception of the issues, usher in beliefs and policies that they believe are truly science-based, and create the impetus for social change.

I emphasize how scientists and policymakers produce compelling narratives with the variety of knowledge claims they have at their disposal. I investigate which scientific claims make it into the story line of early childhood development, and by extension policy discussions, given the uncertain and potentially controversial status of some evidence. In other words, consensus on facts is not abundantly clear, but the claims are nonetheless taken up. How are these claims about neuroscience negotiated and transformed into rhetorical tools that speak to a range of audiences? And at an even more basic level, how do expert groups with competing beliefs, standards, and interests come to negotiate and ultimately agree upon the contents of these narratives?

Through my observations at the neuroscience-based policy symposia series, I gained access to the processes of scientific knowledge production, consensus-making, and translation. There I saw the inner workings of how scientific knowledge is crafted to

communicate particular ideas to the public and to usher in new policies. In one context, a new narrative of neuroscience called the Brain Story came into being. This example comes from my ethnographic work and participant observation at a symposia series in Alberta, Canada that I attended in 2013 and 2014 called "Accelerating Innovation: Telling the Brain Story to Inspire Action." In brief, the symposia series had as its aim teaching practitioners (social workers, doctors, educators, and so on) in the province the new science of brain development to bring science-based evidence into policy and practice. The symposia organizers have longstanding interest in problems like addiction, and ultimately see intervention in early childhood as a key node for the prevention and resolution of major issues. Organizers asked participants to work in small groups – "Innovation Teams" – to design "knowledge mobilization projects" they would take to their coworkers, community, and clients – their "spheres of influence." This symposia series, led by Nancy Mannix, the Norlien (now Palix) Foundation, and the Alberta Family Wellness Initiative, utilizes information and knowledge mobilization tactics developed by the Harvard Center on the Developing Child. Importantly, the Harvard Center has a steering committee of scientists, the National Scientific Council on the Developing Child, that guides the knowledge mobilization process. These organizations and their associated groups take special care to craft narratives about brain development intended to reframe the public's understanding of key issues like child development, responsibility, and problems like addiction. The symposia presented a unique opportunity for an analyst such as myself to understand the relationship between science and policy, given that their ultimate goal is to "bring what we know to what we do" (Alberta Family Wellness Initiative). It was a space in which the bind I discussed earlier in the dissertation – the drive for truth and the desire to use existing, uncertain claims – is negotiated, and concrete solutions are discussed and developed. Spaces like these are

ones in which knowledge is enacted despite uncertainty. In analyzing these activities, I ask after what happens when knowledge is situated and contextual. What happens when knowledge cannot be easily proclaimed to be legitimate, credible, and reliable? How does knowledge production work when the line between scientific and unscientific is not so easily drawn, and how can policy be made? After all, we know from the literature in science and technology studies that the line between science and non-science is discursively produced and often contested (e.g., Bloor 1973; Gieryn 1983; Gilbert and Mulkay 1984; Hilgartner 2000; Jasanoff 1987; Pinch and Bjiker 1984). These arguments about the lines between true and false are also politics by others means. Going forward, I delve into how relevant actors erect boundaries in debates about developmental neuroscience, and the impact of those actions.

Building Consensus for the "Brain Story"

My interviews with neuroscientists clearly evidence that the social developmental neuroscience (SDN) community has reservations about some neuroscience claims, including the ones that are put forward by the organizations I list above. I argue then that scientific consensus has not been achieved. As I have suggested, the neuroscience community I interviewed is heterogeneous. Where one researcher is highly involved in creating science-based policy (like those in the National Scientific Council on the Developing Child), another expresses deep doubts about such projects. At once, neuroscientists may support one neuroscience-based claim while being wary of another. I examine this heterogeneity and emphasize a lack of clear consensus because the symposia series operated under the *assumption* of scientific consensus. Over the course of my participation, I saw cracks in consensus that illustrated how consensus, science communication, and science-based policy are built. That there are cracks in consensus or that facts are negotiated is not an indictment

of those involved in creating science-based policy. The cracks are merely evidence of exactly how complicated producing both scientific knowledge and social policy – and further, social change – truly is. When I suggest scientific facts are political, strategic, and negotiated, I do not mean to say that the ideas are polluted. Scientific practice is always already political, strategic, negotiated, and situated. The examples that follow illustrate just how thorny a process this is. As will be seen, tensions emerge between getting the science right versus having enough knowledge to move forward with for purposes of governance.

Accelerating Innovation

I now draw on my ethnographic experience at a symposia series which aimed to put scientific knowledge of the brain into action in communities and policy. I do this to illustrate how facts travel (Howlett and Morgan 2011) from lab to life – or perhaps life to lab, and to life again. This was a space in which organizers and practitioners pulled scientific knowledge into their daily practices. The series was particularly effective because of how it framed and communicated that knowledge. This kind of space provides insight into how scientists and policymakers negotiate what counts as evidence-based despite concerns about uncertainty. They must, to an extent, align those different worldviews of participants together in ways that do not cause concern, or even offense, to either group.

The symposia series proceeded on the assumption of consensus about the facts. In scientific debates, building consensus is social process, and a fraught one, as I have discussed above. One set of actors might claim that consensus exists or that the science is moving in that direction, while another will dispute this entirely. Facts do not emerge clearly and obviously, and debates are not easily settled with facts. And even when consensus emerges it is not necessarily because the scientific debates have been settled; arguments may remain that have been discursively concealed. Claims about consensus are symbolic action; rather

than being simply a reflection of debate ending, suggesting consensus is a social act that (perhaps prematurely) closes off debate (Campbell 1985, Gilbert and Mulkay 1984, Murphy 2006, Pinch 1981). The science at the symposia series was very much blackboxed; by design, organizers wanted to give practitioners enough scientific details without muddying the waters, and had to simplify a complex and contested field of study for non-experts. The organizers had already decided what would count as credible scientific knowledge at a previous symposia series a few years prior. With considerable effort and consultation with a steering committee of scientists, some form of consensus was achieved, and as I will illustrate below, the audience of practitioners were not often privy to the debates just underneath the surface of this supposed consensus. Out of this consensus emerged the "Brain Story." But the questions remain, why and how is the Brain Story is mobilized to create social change? How do organizers, scientists, and participants of the symposia series envision the world, and how do they imagine a future integrating neuroscience into social policy?

Nancy Mannix, the Palix Foundation, and the Alberta Family Wellness Initiative – the organizers of the series – believe that a number of social problems, especially related to health, that can be solved or at least improved by using scientific knowledge. They additionally believe that disseminating knowledge about social problems to the public is essential for social change. Creating awareness and support of the science is the first step to changing policy. Accordingly, the target for this knowledge mobilization strategy is the community, and those who work closely with the community, especially those serving vulnerable populations. It was thus incumbent upon the organizers to better know the

community they aimed to serve. The FrameWorks Institute[22] – an NGO specializing in communicating science and framing discussions about pressing social issues – did extensive research about Albertans' core beliefs about child development and addiction, and produced extensive data to these ends. Despite being a relatively large province, in size and population, FrameWorks called the whole of Alberta a community. Given the findings from this community along with others in the US, the FrameWorks Institute identified where the community's ideologies were incongruous with what they deem to be the scientific facts. FrameWorks has built a social technology for changing public opinion, which is based on its research into existing public beliefs. This is highly significant because while they do maintain that the public does not have adequate knowledge of the science, their strategy differs from a standard deficit model approach. In the public understanding of science literature, what's been called the deficit model operates under the assumption that the public lacks knowledge of science, and that this knowledge gap leads to less public support of scientific claims and research. FrameWorks does maintain that the public needs to understand the science, so some of their perspective is consistent with some deficit model assumptions. However, FrameWorks and its associated organizations argue, correctly if we take seriously the public engagement literature, that the public does not merely soak up information that is directed at them. They believe that if the public holds beliefs that contradict the new science, it will ignore the science in favor of what conforms to and confirms familiar discourses. I will give greater detail on the dominant discourses and competing discourses FrameWorks puts forth to challenge them, but one example is instructive. FrameWorks observed that a discourse of

[22] The FrameWorks Institute is closely connected to the Harvard Center on the Developing Child. Its mandate has expanded, but it was founded for the purposes of studying and disseminating discourses about childhood development.

genetic determinism interferes with communicating the importance of the environment and relationships in determining children's development. When they performed large-scale surveys, they found that the public believes a child's developmental trajectory is determined by biology and genetics before birth. In other words, members of the public think children, especially rotten ones that become rotten adults, are "born that way." Despite scientists' continual refrain that no good scientist ever believed in anything like genetic determinism, and regardless of proclamations of being in a post-genomic era, FrameWorks suggests that a genetically determinist discourse is common and prevalent amongst the public. They put forth another gap, that between science and publics. FrameWorks suggests that the scientific consensus does not support a genetically determinist viewpoint on human development. They argue that the environment is far more important to understanding how the brain develops, and that this idea is supported by credible scientific experts. FrameWorks understands the basic problem to be one where the participants are unaware of or unconvinced by a more environmentally-inflected perspective, and that there is a gap in between what the public believes and what scientists and other experts know. The participants at the symposia series were entreated to span that gap. Organizers wanted participants to learn the current scientific findings about development, challenge "incorrect" beliefs that the community holds, and learn to communicate new and what they consider to be more legitimate scientific findings to public.

Consistent with the ethos of the symposia on the whole, the FrameWorks' survey data was presented to us, the non-experts, in an accessible manner, complete with figurative

language, cartoon illustrations, and appropriate simplification (cf Hilgartner 1990).[23] They told us was that this constellation of public discourse is like a swamp.

> The "swamp" describes dominant features of public thinking. The swamp of public understanding comprises patterns of reasoning and assumptions that can help or hinder the successful communication of a message. (Norlien Foundation 2014, 86)

The swamp, from this perspective, is a formidable obstacle in successfully communicating science. Further, it is potentially dangerous. The apex predator in the swamp of science communication is the alligator. For science communicators in training, like participants, he is a sworn enemy who distorts meaning.

> Some existing cultural models, or dominant patterns of thinking, are like alligators in the swamp: they eat messages and twist their meaning so that the intention of communication and its actual perception are two very different things – creating powerful "lost in translation" moments. (Norlien Foundation 2014, 86)

What kinds of "gators" are we dealing with? And how are they distorting and harming our message?

> In communicating about early childhood development, these "major gators" include the ideas that it is the exclusive responsibility of parents to raise children; that successful development is wholly dependent upon individual drive and motivation; that developmental outcomes are genetically determined, so there's not much that can be done about them; and that what doesn't kill you makes you stronger. These and other ways of thinking about children and development impede people's ability to consider fundamental tenets of the science of development. These major gators underpin much of how Albertans think about children, childhood development, and a broad range of other issues – such as education and addiction. (Norlien Foundation 2014, 86)

The dominant discourses or "gators" – parental responsibility; individualism; genetic determinism; and ideas that negative experiences build character – must be minimized or reframed before audiences can take up new messages. Thus, FrameWorks and the other

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[23] It is testament to the effectiveness of this communication style that I can recall the details of their surveys and approach with ease.

organizations pulled together a core story, or what they eventually termed the Brain Story, to aid participants into their ventures into the swamp.

> The swamp is the key to a game-changing approach to communications: a core story. A core story helps communicators navigate the swamp, communicate messages effectively, and create support for more effective policies, programs, and practices. A core story is a Common set of elements, that is Organized as a story, Responsive and flexible, and Empirically tested. (Norlien Foundation 2014, 86)

FrameWorks told us repeatedly that these narratives had been tested for effectiveness. Beyond their surveys about the state of public understanding in the province, they also conducted trials testing the narratives they created. FrameWorks researchers told me that over a year of research and testing goes into the production of one of their metaphors. Symposia series attendees were promised that we would be successful in communicating our ideas and achieving all the organizations' knowledge mobilization goals if we used the story in the way that they had designed it to be used. Participants saw video of this metaphor testing. Using focus groups, FrameWorks taught and tested candidate narratives or metaphors of child development and addiction to "average" people. They showed us video evidence of these average people's false beliefs or "gators." The experimenters then taught the groups the new ideas. They later tested their comprehension of those ideas. Individuals responded well to these forms of communication and education as evidenced by how quickly they learned and understood those facts. It did appear that their understanding had been transformed – although the question of how long the audience retains this knowledge remains an important, unanswered one.

So what is this narrative? The Brain Story is relatively simple, and reflects the social determinants of health model. The social determinants of health, as defined by the World Health Organization, "are the conditions in which people are born, grow, work, live, and age, and the wider set of forces and systems shaping the conditions of daily life. These forces

and systems include economic policies and systems, development agendas, social norms, social policies, and political systems" (World Health Organization). At its basis, the Brain Story suggests that "experiences in early life interact with genes to affect the developing brain and influence health outcomes throughout life, including those relevant to mental health and addiction" (Norlien Foundation 2013, 9). There are five key components of this narrative. 1) *Brain development*. The development of brain architecture in early years is especially important. The architecture is the foundation upon which further development across the life course is built. 2) *Serve and Return*. The development of brain architecture happens through interactions with caregivers. Children reach out for contact with adults using language or actions, and adults mirror that activity in response. 3) *Genes and environment*. Environmental cues turn on genes, and positive experiences are required to turn on genes in the right way. These environmental signals have the potential to last a lifetime. 4) *Brain as air traffic control system*. Executive function, the ability to juggle multiple tasks and focus attention, needs to be built early. This occurs through positive interactions with caregivers 5) *Toxic stress*. Severe adversity encountered by children without the support of parents disrupts development. That stress gets built into the brain and the body.

The Brain Story supports the idea that childhood development and social problems are dependent upon experiences and relationships. This model advocates for community involvement and responsibility over individual blameworthiness. It also suggests that human bodies and life trajectories are malleable. In such a way, audiences begin to see how molecular evidence is entangled with the social. When used in the service of arguments about the social determinants of health, evidence about individual brains is used for the purposes of social change, and in particular, to speak to issues of governance, responsibility, and social justice. Considering this, I suggest that the Brain Story is consistent with a kind of

sociological imagination (Mills 1959), wherein personal troubles and public issues are inexorably linked. The Brain Story adds a biological component to this relationship.

While attending the symposia series, participants were entreated to listen to presentations by experts, go to workshops where that knowledge was further clarified, and then participate in group activities that helped us implement what we learned in our own contexts. I learned the Brain Story primarily through short, well-produced videos that used metaphors and animation. They were simple, attractive, and, based on symposia participants' reactions, extremely effective. In such a way, I along with other participants learned the overall premise of brain development, and then the key components of that story. Through constant and consistent iteration of the Brain Stories in presentations, workshops, and group work, the language and concepts became second nature to us. On the second day, in fact, a participant joked with me about "drinking the Kool-Aid." This sentiment was not altogether false. The organizers, however, framed things in a slightly different way, and termed this "getting on the same page." At the end of the week, I noted in my field notes that I believed that despite my more critical perspective, I myself had imbibed that Kool-Aid. I left the symposia series each year with childhood development and brain architecture virtually emanating from my pores.

How did the audience react to these claims? As I have noted in previous chapters, the practitioners, and even some of my neuroscientist interviewees, told me that this research tends to confirm many of the general insights of social psychology about poverty, adversity, inequality, trauma, and the like from the last 30 years. Some were excited that their work and insights were now being verified by neuroscience, while others lamented the need for these older claims to be confirmed by new, more "scientific" techniques. The neuroscience told them what they already knew, and confirmed the importance of their

interventions and concerns. Whatever the reaction, practitioners were generally happy to learn about the new neuroscience discourse, and planned to implement it in their work with clients. A number of the practitioners I spoke with were less concerned with having cutting-edge, science-based information, even though they presumably attended the symposia series to attain just that kind of knowledge. By packaging the science into a coherent narrative and providing training and materials to practitioners, the organization made the facts useful. We see then that the successful use of evidence does not hinge upon certainty; rather, it depends upon how practitioners make sense of the discourse in the context of their own knowledge, from both experience and previous knowledge from those "soft sciences," and the usefulness of the data for their work with patients. They accepted new facts about the brain-based narrative because the science allowed them to maintain their existing beliefs and practices. I do not believe it is incidental that this scientific work that puts primacy on the social speaks to their more sociologically-oriented education, politics, and work.

Though FrameWorks claim above that the brain narrative itself is flexible and can be tailored to fit any number of contexts, my experience and observations illustrate that it fell short of this goal. At the symposia series in 2013 and 2014, each group contained several members who had attended previous symposia, particularly the ones creating scientific consensus and designing the Brain Story years prior. In my group, Ken was our resident scientist. He holds a PhD in psychology, and works in both research and the clinic. During our first year, he and our group facilitator were our go-to resources when we needed clarification about the narrative and the science supporting it. This was helpful, but Ken became, with no malice or ill intent, a kind of enforcer of the narrative. When we asked critical questions or expressed confusion, he told us again and again to go back to the Brain Story, literally pointing to chart with the major points written on it, proclaiming that it was

"all there" already. When we suggested that the narrative might not work in our contexts, he was adamant – we did not have to worry about those kinds of questions because the narrative was supported by science and scientists, and tested for its efficacy in our community. Our group was not the only one that expressed doubt about the universality of the message. At week's end, all 20 groups had to present their projects for disseminating the Brain Story. During those presentations, I noticed that many of the groups proposed projects to test the narrative for its efficacy in their small communities. For those serving Francophone and First Nations populations, the supposed universality of the narrative was an obvious lacuna. First, there were no French or Cree language translations, a barrier of the most basic sort. Second, there was general sense that some of the metaphors (serve and return and air traffic control specifically) were not legible for poor, marginalized communities. One presenter asked questions like the following: "will the First Nations moms we work with understand serve and return if they know very little about tennis or other sports? Will they understand air traffic control if they know even less about planes and airports?" Though FrameWorks conducted intensive research on in Alberta, this American organization was likely not well versed in the ways that seemingly universal Canadian narratives might alienate and homogenize an otherwise diverse set of communities and nations within the nation. In the least, the critique suggests that communicating the Brain Story may be more difficult than was initially thought.

It does speak volumes of Nancy Mannix's commitment to change and capacity as a philanthropist that she was incredibly receptive to critique; she understands it as essential to the process. When we came back in 2014, she was explicit in her request for feedback – what worked and what didn't? As a group, participants shared their experiences and found that there were barriers to communicating the Brain Story in the intended fashion. Jody reported

that there was neither the time nor was it the appropriate context to share the brain story in her work with addicts in the earliest stages of recovery. Frustrated, she asked, "At which point in triage am I supposed to tell them about how childhood trauma has changed their brain architecture? When am I supposed to show them the video?" Phillip had a unique barrier to sharing the narrative with clients who have children with significant disabilities. He found it difficult to talk to these parents about normal child development because their children had not and were not expected to reach normal milestones. He was reticent to share the story with clients because "normal" stories are painful; it is common for these parents to grieve the fact that their child will move along another kind of developmental path. Being sensitive to this, he realized that, in his context, sharing the story might do more harm than good.

These moments are suggestive of the difficulty of communicating and implementing new ideas. What is more, they reflect the importance of context for knowledge mobilization, and that "universal" ideas, however well researched, cannot always speak to the local and transform local understandings and practices. We see that some discourses have differential uptake or are less successful than others. This is consistent with Hajer's discussion of storylines. This narrative may be easily incorporated into some participants' contexts, while some practitioners face context-specific challenges that make the Brain Story untenable. Even if the narrative is successfully integrated into popular discourse, policy, social programs, and education across the province, there are spaces in which it is incompletely absorbed. This is not unusual in the case of sociotechnical vanguards who act "to realize an edgy 'vanguard vision' of a future attainable through science and technology" (Hilgartner 2017, 27). Their visions do not always come to fruition, however.

Toxic Stress

The consensus underlying the Brain Story was also an area of slippage. The case of toxic stress illustrates that building consensus is a work in progress, and further, that the consensus remained problematic even after it was officially achieved. Despite efforts on the part of the organizers to stage a coherent narrative, participants occasionally saw evidence that facts were less stable than they appeared. It became clear over the course of the symposia that key debates were not settled. The cracks in consensus were noticeable at some points, particularly in one presentation during the first year by a prominent scientist. In a candid moment, as an aside to her formal slides, she confessed that she and the other scientists were not wild about the term "toxic stress." It had apparently been a point of contention between scientists and the communication professionals at the Harvard Center on the Developing Child. Despite being scientifically inaccurate, toxic stress is part of the official Brain Story narrative, and is endorsed by scientists. Why is this the case, especially when I have suggested earlier in this dissertation that scientists are actually quite uncomfortable with overstating their claims? They worry that toxic stress is inaccurate, or at least miscommunicates the facts and implications. So why do scientists allow inaccuracy to make its way into evidence-based policy, especially when they are, as a policymaker joked, pedantic about details? As I have noted above, Hilgartner (1990) suggests that scientists maintain that there are both appropriate and inappropriate (or distorted) simplifications of science that occur in the context of science popularization. Indeed, I witnessed scientists in this arena doing this kind of boundary work; it was especially true that scientists critical of policymakers are apt to categorize these claims as something other than science, in particular, "folk neuroscience."[24] The example of negotiations about toxic stress, however, shows that

[24] It is not incidental that the strongest opponents of this work are not a part of the National

some actors believe this is an appropriate simplification of science while others believe is a distortion of the science. Further, it suggests, in line with the literature on boundary work (Gieryn 1983) that the distinction between science and non-science, appropriate simplification and distortion (Hilgartner 1990) is context-dependent.

The Alberta Family Wellness Initiative maintains that stressful experiences in early childhood impede healthy development. They also argue that caregivers and communities have a significant role to play in how stress affects the body: "Stress is the bad guy in the story of child development, but we have a lot to say as a society about the power of the stress our children are exposed to" (Norlien Foundation 2013, 9). Not all stress is equal, and not all stress is negative. Some stress is good and even necessary for development. As such, they categorize stress into three types: positive, tolerable, and toxic.

> A **positive stress response** happens in situations like the first day with a new caregiver or receiving an immunization. It's a normal part of healthy development and is characterized by short increases in heart rate and hormone levels. **Tolerable stress activates the body's alert** systems to a greater degree as a result of more severe, longer-lasting difficulties, such as the loss of a loved one or a frightening injury. If the stress is time-limited and buffered by supportive relationships with adults who help the child adapt, the brain and body recover from what might otherwise be damaging effects. A **toxic stress response** occurs when a child experiences strong, frequent, and/or prolonged adversity – such as physical or emotional abuse, chronic neglect, mental illness or addiction in a caregiver, exposure to violence, and/or chronic family economic hardship – without adequate adult support. (Norlien Foundation 2013, 9, emphasis in original)

The caveat "without adequate adult support" is significant. Under this model, experiences that would otherwise be toxic can be made less toxic by the addition of a supportive and nurturing caregiver. In presentations, scientists and policymakers alike emphasized this point,

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Scientific Council on the Developing Child. In order to produce a coherent narrative, criticism and opposition must be to a certain extent excluded. Those most vocal critics are less likely to find some common ground upon which to build consensus and policy.

and to positive social and political ends, I believe. While they did argue that postpartum depression can be a source of toxic stress, it is not necessarily one. The effect of this experience can be mitigated by support of other caregivers. This was cleverly done. In framing things in such a way, the organizers avoid both blaming mothers and suggesting that children of mentally ill parents are doomed. From this perspective, there are almost no foregone conclusions. Again, the malleability of biological response and the plasticity of the brain were strong themes. This viewpoint also allows for greater community involvement in shaping children's development, and disrupts dominant discourses of individual motivation and responsibility. Another example concerned witnessing domestic violence, which most would understand as damaging, unequivocally. Presenters maintained that even this kind of experience might not derail development if the child was able to process these circumstances with a supportive adult. If an adult is present, supportive, and caring during these stressful events, the cascade of negative biological effects can be stopped. If a child witnesses violence, but experiences it with an adult that can mediate that experience for him or her, the stress response could be lessened. Here, the experience, its social context, and embodied response are all constitutive of a child's development.

Toxic stress is bad for development because of its effects on the brain and body. One instance of toxic stress does not make for unhealthy development, but multiple experiences and constant exposure to stress are more likely to leave an indelible mark on a child's stress regulation biology.

> Prolonged activation of the stress-response systems can disrupt the development of brain architecture and other organ systems, and increase the risk for stress-related disease and cognitive impairment well into adulthood. Toxic stress literally gets built into the brain and the body. Society can work to prevent toxic stress responses in young children by reducing their exposure to extreme environments and by providing buffering relationships at school and in the community. (Norlien Foundation 2013, 9)

The quote above illustrates the most fundamental message from those organizations I mention here, which is well-aligned with the ideas from the larger field, especially as expressed by my interviewees and the reports featured in chapter two. To use Clyde Hertzman's phrasing, toxic stress is "biologically embedded." Within this text we also find embedded social and political imaginaries of how children should be cared for and how society should be governed. Society can and should provide support for children to better cope with stress. It is not the responsibility of individual parents; the community must provide a healthy environment for children, especially in schools.

Toxic stress appears congruous with the scientific research; stress produces biological effects that go on to have negative implications for development. What did scientists disagree with, and which details gave them pause? Hearing the presenter express her frustration with and ultimate acquiescence to the concept of toxic stress offered me the opportunity to see some of the breakdowns in dramaturgical cooperation (Hilgartner 2000). To understand what took place behind the scenes to get toxic stress into the official Brain Story, I spoke to a key actor from the FrameWorks Institute. She told me that what scientists were uncomfortable with was the qualifier "toxic." Toxicity carries negative connotations that she says the scientists involved in the creation of the Brain Story were uncomfortable backing. In other words, toxic seemed to them polemical rather than scientific. Further, parsing stress into these separate categories was problematic from a scientific standpoint; there is no scientific rationale for doing so. Biologically, stress is stress: its biological effects are a matter of varying degrees not kinds. Put another way, different categories of stress activate the same stress response systems and touch the same mechanisms. As was illustrated above, the Brain Story suggests that the toxicity of toxic stress changes depending on social context. This reportedly made some of the scientists wary.

Debra, one of FrameWork's founders, told me that the steering committee of scientists, called the National Scientific Council of the Developing Child, became convinced to back toxic stress only when they heard that the common narrative being used by the public and politicians was the exact opposite. They justified the use of the qualifier "toxic" because it they needed it to build the right social and scientific perceptions into the public. When studying societal discourses of adversity, FrameWorks came across a significant misperception, or to use their words, a "big gator." They found that the dominant discourse upheld by many Americans and Canadians is summed up in the adage "what doesn't kill you makes you stronger." Their research revealed that people believe that severe stress and adversity is good for children because it builds character, for lack of a better phrase. This belief is incredibly problematic for these organizations and also for those familiar with current findings in both developmental psychology and SDN.[25]

FrameWorks and the steering committee of scientists were thus faced with a formidable task. How would they convince the public that stress is bad for children when most people are convinced that adverse experiences are necessary precursors to a successful life? How would they convince policymakers that something like poverty does not build character, but instead lays the foundation for poor mental and physical health, even addiction? Using language that best conveys the negative consequences of stress is the answer. Toxic stress hooks into other discourses around purity, exposure, and poisoning. Using toxic stress while discussing children's health may harken to familiar public health concerns around lead poisoning – public health campaigns advertise for lead testing in early

[25] The notion that success only comes from struggle and even trauma is so ingrained in our society that even I, a critical analyst of discourse, found myself questioning the pronouncement that all adversity is negative.

childhood, and it is feasible that parents of young children are aware of the damages of lead exposure. The recent crisis around lead poisoning in Flint, Michigan brings the importance of early childhood development into stark relief. Children exposed to lead in drinking water in Flint may face lifelong developmental problems. They may have permanent damage by virtue of their experiences and environment. While never explicitly referred to, the specter of lead poisoning can be used to great discursive effect. Stress, like other toxic exposures, marks the body in phenomenal ways. Faced with knowledge of the dominant discourse on stress, the scientists involved took a pragmatic view; although toxic stress is not exactly right, it directs the public to an idea much closer to current scientific consensus than the existing viewpoint. Rather than engaging in boundary work to proclaim toxic stress unscientific, they adapted the scientific claim to fit the social context, agreeing to the imperfect concept of toxic stress with the goal of ultimately furthering scientific truth. In other words, they adjusted the boundary between appropriate simplification and distortion when faced with a new context. In the context of existing beliefs about stress, they decided that "toxic stress" was an instance of appropriate simplification. They justify this action because communicating the science in such a way is more effective and produces specific scientific discourse in the audience in the long run.

Nature, Nurture, and More Gators

Cracks in some aspect of putative consensus were more explicit, as is the case with toxic stress, while other instances were subtler, and required some background knowledge of the field to better discern them. Some of the basic science presented at the symposia series was augmented with discussions of key scientific studies. Presentations about epigenetics, for instance, included discussions of the details of studies in mouse and rat. I elaborated on this in chapter 3, where I suggested they served as powerful pedagogical tools. These were 1) the

Agouti mouse experiment, which is memorable for its visual display of how the same genes can produce different phenotypes, and 2) the rat mothers experiment, in which good maternal care, in this case licking, produces less anxiety in pups. In our context, the imagery of the mouse experiment was shown to illustrate, literally, that genes are not destiny. The Agouti mouse case was discussed in greater detail because it strongly and effectively emphasizes the concept that environment matters. While the rat study does not produce memorable images, it is an example that can be readily compared to the human experience of nurturing children. Again, this study is put forth to suggest that "nurture," particularly good mothering skills and a calm disposition, trumps "nature."

One of the key functions of the symposia series was to dispense with a big gator, the all too common notion of genetic determinism, which is said to pervade public understanding of development and life course. The Harvard Center and the symposia series seemed to emphasize "nurture" to the detriment of "nature." This does make sense, considering that they understand themselves as fighting a discourse that holds the exact opposite. But it does have the effect of simplifying the science in a way that is distressing to other scientists. To be sure, the conference presentations did suggest that genes and environment matter, but there was very little discussion of the genetic component of development. The emphasis that organizers place on environment or nurture is another example of how people in science communication and policy use ideas that do not reflect the accuracy and complexity of the scientific literature to shape the beliefs of the public. In this way, the process mirrors the negotiation of toxic stress. While the intertwining of nature and nurture should be emphasized, those involved in science communication and policy do not want to give genetics any additional credence. Genetics does not need a vocal champion because it is the dominant discourse. To challenge the supremacy of genetic determinism,

they emphasize the nurture part of the argument to pull the public into the right direction. This illustrates how scientists and policymakers justify using knowledge they believe is problematic; they can and do use those claims because they serve the ultimate goal of better improving the state of scientific knowledge and the expansion of science-based policy.

Other interviewees aware of the Harvard Center and organizations affiliated with it have been critical of this singular focus on the nurture side of the argument, as they tend to view the whole topic with far less certainty, and more specifically, to view nature and nurture or genes and environment to be more interactive. The interactive relationship between nature and nurture, and uncertainty around how the relationship unfolds are reflected in both my interview data and the reports in chapter two. Scientists I have spoken with suggest that individuals at the Harvard Center support an "environmentally determinist" perspective on human development. They argue that the Harvard Center actors are vocal in their dismissal and disdain for genetic explanations of any sort. For my some of my neuroscientist interviewees, those not part of the National Scientific Council on the Developing Child, this represents a fundamental, and perhaps dangerous, misstep that over- or misinterprets the scientific evidence. These arguments about appropriate interpretation reflect debates about what constitutes the appropriate use of neuroscience. Would critics call this "folk neuroscience?" Is neuroscience, particularly in the form of the Brain Story, merely invoked to uphold political ideas one desperately wants to be true?

The ultimate effects of this strategy are yet to be seen. Will it lead to an environmentally determinist (and for some, problematic) understanding of development, or will it nudge the public into a more nuanced understanding of the relationship between genes and environment? There is controversy within this group about this issue. Hilgartner notes that "these vanguards typically share some commitments, […] but they are rarely

completely unified" (27). Following that, I argue that they do constitute a sociotechnical vanguard because of their shared desire to promote a vision or narrative that challenges genetic determinism and emphasizes the role of social life in brain development. It is too early to be sure what the results of this strategy will ultimately be, but my sense is that it may reinforce the decades-long debate of nature versus nurture. For those convinced by these arguments about the impact of experience, the pendulum may simply swing towards nurture without radically reframing the nature/nurture debate. The swing towards nurture may satisfy some members of this vanguard, but not others.

Conceptualizing Experience: Evidence of Poverty or Adversity?

When I moved between my participant observation data, interview transcripts, and scientific studies, I noticed that there were different ways of understanding and defining the nature of experience and which experiences mattered. "Evidence of what" turned out to be a less straightforward question than it initially seemed. How have scientists and policymakers conceptualized experience? Some of my interviewees used data and ideas about poverty in their work, and others used adversity. While adversity is arguably the larger conceptual umbrella, some policy-engaged actors, particularly Nancy Mannix, choose not to emphasize poverty because she believes that adversity speaks to a broader audience, for reasons I will explain below. Accordingly, the Brain Story is a narrative of adversity and trauma rather than race and class. These observations raise a question: Why do particular ways of conceptualizing development come forward in the policy discourse?

One subset of researchers in this field[26] specifies this adversity in another way, and hones in on socioeconomic status. They aim to understand disparities in cognitive function as a result of socioeconomic status; low socioeconomic status is an obvious and pervasive form of adversity from this view.[27] Evidence from this research perspective is ultimately evidence about the impact of inequality and poverty. This kind of work follows in the footsteps of public health research and intervention that understands poverty or income as an essential factor in the social determinants of health. The expert reports from the IOM and CAHS that I detailed in chapter two also hold that marginalized and disadvantaged children are more at risk. Class and race, after all, are significant to a child's experience in the world. The research perspective also emerges out of individual observation and a commonsense understanding: poor kids suffer disproportionately. Many of my interviewees were expressly concerned with inequality as both a matter of social justice and a research question; they understand this inequality as the primary cause of disparity in children's cognitive function. This way of understanding the relationship between inequality and brain development often leads researchers towards solutions that mitigate income equality. Many of the interventions my interlocutors have proposed have to do with reducing inequality – interventions politically difficult and practically infeasible, some argue. For instance, this research tends to suggest that changes to the minimum wage or simply giving poor families more money would make a positive impact on poor children's brain development.

Given the pervasive effects of poverty, why is its impact emphasized less by some people involved in work? Those researchers and policymakers I engaged with in my

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[26] Most of whom are not included as part of the National Scientific Council on the Developing Child.

[27] This mode of conceptualizing the neuroscience of development has come under scrutiny, and I take that debate on in depth in chapter 6.

fieldwork in Alberta are instead focused on experience and adversity. None of them dispute the notion that poverty is a form of adversity and that poor children face greater risk. However, they have framed the problem as one of adversity and trauma, and likewise, the measures and results are formulated in those terms. This group uses a large-scale public health study on Adverse Childhood Experiences, the ACE Study. In their analysis of the health of over 17000 adults, ACE Study principle investigators Vincent Felitti and Robert Anda discovered that childhood adversity is strikingly common (Felitti et al. 1998). This is particularly significant given their findings that higher ACE scores (4 or more) correlate to greater public health ills, both related to physical and mental health. They produced the following illustration (Figure 2), which summarizes their findings:

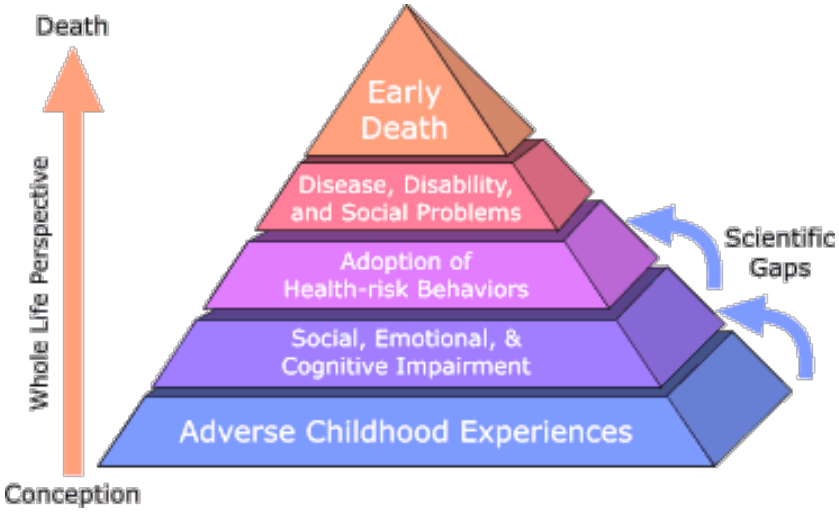

Figure 2. The ACE Pyramid. Credit: Centers for Disease Control and Prevention, Charles Whitfield.

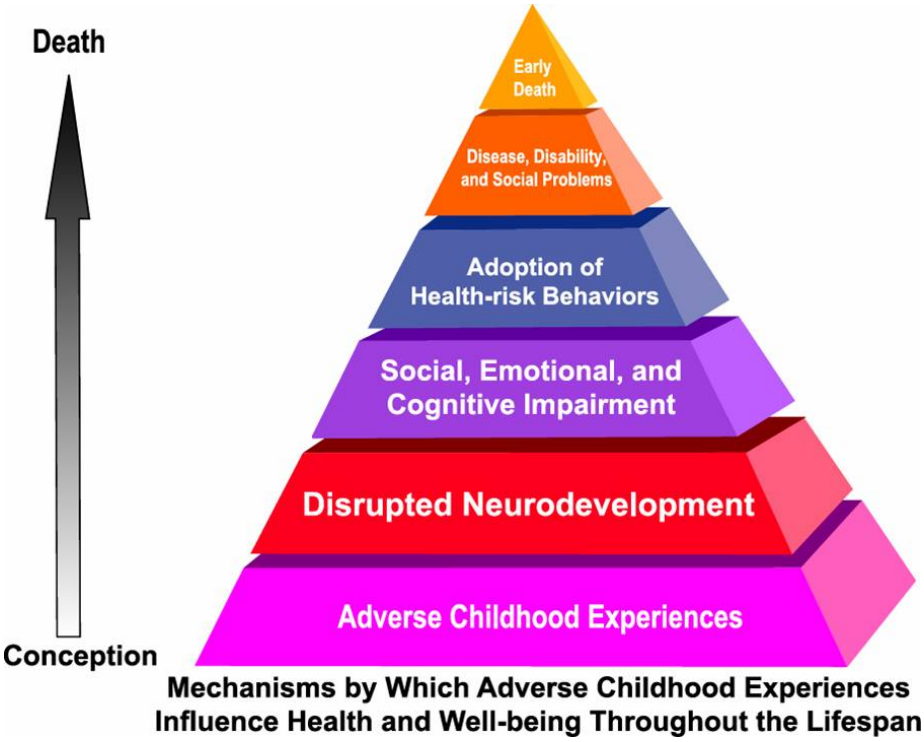

Figure 3. Mechanisms by Which Adverse Childhood Experiences Influence Health and Well-being Throughout the Lifespan. Credit: Centers for Disease Control and Prevention.

The model has been updated to account for advancements in the scientific knowledge about experience and development (see Figure 3). In Figure 3, one step "Disrupted Neurodevelopment" has been added to the pyramid, directly above "Adverse Childhood Experiences." Poverty can fit into this model. It can be accounted for in one or more steps in pyramid: "Adverse Childhood Experiences" and "Disease, Disability, and Social Problems."[28] It can be both cause (adversity), and effect (problems). The "scientific gaps" from Figure 2 are not present in Figure 3. Presumably, this suggests that the CDC believes some of these gaps have been closed. It is worth noting that the ACE model has wide support; many trained in psychology and social work are well-versed in this model.

[28] One of the questions these researchers have to tackle is the supposed transmission of poverty over subsequent generations. There are discussions about whether both poverty and trauma are inherited biologically, culturally, or by some combination of the two.

Symposia series organizers and participants often use measurements and tools provided by the ACE Study, the most significant being the ACE Score Calculator.[29] It is easy to use and its results simple to obtain; individuals answer 10 yes or no questions, and the score is calculated by tallying the number of 'yes' answers. It is increasingly being used in clinics and social programs to better assess risk. The ACE Score Calculator screening tool is designed to cover different types of trauma: physical, sexual, and emotional abuse; familial dysfunction; and lastly, emotional and physical neglect. The greater the number of categories of traumatic experience they report, the greater their risk for serious health problems, including suicide, addiction, and chronic disease. Poverty is not directly measured through this tool. One question does include "did you often feel you did not have enough to eat…" This gets at this issue indirectly, but this is more strongly framed as evidence of neglect. The entire question reads:

> Did you often or very often feel that you didn't have enough to eat, had to wear dirty clothes, and had no one to protect you or that your parents were too drunk or high to take care of you or take you to the doctor if you needed it?

The most obvious reason that people I spoke with used trauma and adversity rather than poverty is because, sadly, trauma in childhood is exceedingly common, and occurs across all socioeconomic classes. Neither is it insignificant that the tool for measuring adversity is simple and easily transferable into a wide range of contexts. Nonetheless, the reports, along with other publications, tell us that poverty and marginalization are central concerns. So why is poverty left out of the ACE Score Calculator, and therefore, the explanatory model?

One clue comes from my interview with Nancy Mannix. I asked her why her foundation focused on adverse childhood experiences and trauma when other models used

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[29] See Appendix A for the ACE Score Calculator

poverty to frame the discussion. The reason I asked Mannix about it more explicitly is because of the growing number of neuroscientists and others biologists who integrate poverty into their scientific work, be that in their theoretical engagement with the ideas or even including it in their causal models and experimental variables. Further, many practitioners at the conference who were supportive of the ACE model were also very much interested in discussions of poverty and race. As a philanthropist and policymaker, Mannix is concerned with large-scale social change, and it was clear that she had given this issue much thought. She responded to my question about poverty with the following,

> In the Depression a lot of communities came together and they didn't have much but they had a resilience around connections and relationships that helped them mitigate and buffer what was happening economically. And so to say poor people aren't good parents, kind of what that argument is, right? Well, that's not true. (Interview Nancy Mannix)

There are several themes contained in this short passage. Mannix employs our memory of The Great Depression, and in doing so, emphasizes our collective ability to overcome great adversity. As an advocate for social change, this focus on resilience and the possibility of alleviating suffering related to social problems is important. And perhaps due to this positive framing, she has been an incredibly effective champion for this cause. She understands social problems through the possibilities that they offer – such adverse conditions are opportunities for heightening resilience and strengthening relationships.[30] This perspective holds that certain qualities and relationships are protection against some adverse experiences.

Moving directly to The Great Depression and resilience, however, seems to me a somewhat unusual first response. Referring to it offers up poverty as a distant memory and

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[30] Clyde Hertzman had a similar sensibility about the power of community. He utilized yet another measure, the Early Development Index (EDI), which provides data about childhood development at the scale of the community. Communities have been given this data, and they have endeavored, with the help of researchers, to improve their scores.

problem solved instead of being a common, current, and pressing social problem. It becomes quite clear why she does not want to talk about poverty in the next sentence: "poor people aren't good parents [?] […] that's not true." She worries that an emphasis on poverty leads to blaming parents and poor people. Using adversity rather than socioeconomic status – utilizing one type of evidence of experience over another – is a strategy to maneuver some tough political terrain. Engaging in discourses about poverty may be more trouble than it is worth. Mannix offers more on why poverty is not her preferred framing or metric:

> Our piece is [that poverty and being poor] aren't helpful ways to talk about what we think is the bigger issue, which is how adverse childhood experience really is the fundamental issue we're talking about and it goes across every socioeconomic realm. If we continue to talk about poverty, then we make it about them and we don't make it about all of us and this is about all of us. (Interview Nancy Mannix)

Framing the problem in terms of adversity grants it a universality that the framework of poverty does not allow. The discourse of universality may prove most effective for getting an entire population interested in the problem. Making claims about a particular group, especially one that is disadvantaged, does not lead to attention from important stakeholders. Implicit in our discussion are discourses about poverty in Canada and the United States; poverty is associated with less favorable characteristics, and talking about poverty often does not result in sympathy for those in poverty, even children. Pulling in evidence around the universality of adverse childhood experiences turns out to be a far more useful for making social change. Further, I might say that poverty has more conceptual baggage – it is difficult to parse out the effects of class and race, socially and scientifically. Intersectional analyses, in fact, suggest that these categories – class, race, gender, and sexuality – operate together to structure systems of oppression (Crenshaw 1991). In Canada, especially Western Canada, the Aboriginal community is marginalized and disadvantaged. Mannix notes that when we use poverty, "it also allows people in our culture […] to point and say, in our case it's the

Aboriginal, well there's the problem. They are not the problem!" Mannix deals with this fraught political issue by seeking out a specific conceptual perspective and avoiding the pitfalls of a measure like socioeconomic status, arguing that she and her foundation "did not believe that was a productive way for us to think about it. We were more interested in ACE as an across the board phenomenon, not owned by any particular group that we classify." In such a way, it can be said that a complex political negotiation is at least partially resolved through changing the scientific variables and factors. This has allowed them to avoid some of the criticism that others who explicitly link the brain and poverty have received.

Despite Mannix's desire to keep poverty out of the discussion, she did note that many of her American colleagues do use the concept in their scientific and policy work. I should note that Mannix is not against the use of poverty as both analytic and rhetoric; rather, her foundation has chosen a different set of concepts, ones that she believes will best communicate its message to the community. However thorny an issue, there are those who are deeply invested in using socioeconomic status. One scientist and presenter at the symposia series, Charles, spoke passionately about the problem of poverty in America, and suggested that it was almost impossible to get American citizens and policymakers to get out of a "pulling yourself up by your bootstraps" mentality, but that he was working on it. His observation illustrates how difficult it is to talk about inequality, but that many are still committed to this concept precisely because of its potential power. What is more, students in science and medicine are often unaware of the relationship between socioeconomic status and biology. After I interviewed a professor, Trevor, he passed me a textbook that he uses for his undergraduate students. "There's nothing about socioeconomic status in there. Can you believe it?!" Socioeconomic status has had less attention in the scientific literature, but it is not primarily because the science is "not there." Researchers and reports make plain that

disadvantage and marginalization matter a great deal, yet, political concerns make the evidence fraught. It may be the case that there is strong evidence about the role of socioeconomic status as a source of adversity, but that it is politically untenable. What actors treat as reliable evidence is at least partially contingent upon politics. The use of narratives about the brain center not around truth; rather, the question is, which ideas can be effectively deployed and transform dominant discourses?

Reflecting Upon Narrative Production

I used my ethnographic fieldwork at the "Accelerating Innovation: Telling the Brain Story to Inspire Action" symposia series to help make sense of how scientific knowledge is transformed, negotiated, and narrativized for the purposes of building science-based policy. As a new narrative of how biology and sociality interact, the Brain Story campaign is an effort to realize a vanguard vision for the future of early childhood policy. This project has been, and continues to be, successful, and the province has been lauded as a "Gold Standard" for knowledge mobilization by state and non-state actors. The Alberta Family Wellness Initiative has disseminated materials for the public, including commercials, a web series, and a number of publications. The participant groups have implemented new programs and knowledge mobilization plans across the province. Further, the model is being exported across Canada, the United States, and internationally. While other aspects of Nancy Mannix's knowledge mobilization process concern more explicit policy goals like creating legislation and policy, most significantly Alberta's Social Policy Framework (Alberta Government 2013), the aim of this symposia series was to inform practitioners who would then disseminate this knowledge to the public. Public knowledge and support of science are viewed as essential to greater goals of bringing what is known to what is done.

By looking at the production of the Brain Story, negotiations about contested terms like toxic stress, reframing the nature/nurture debate, and choosing a more universal and less politically fraught causal model of adversity rather than socioeconomic status, I show in detail how political and scientific are always entangled with respect to sites and policies related to social developmental neuroscience (SDN). I have also illustrated that even for scientists, truth is a contextually dependent term. There is no perfect "truth" upon which to build policy, and scientists recognize that policy must be made. This relatively young field has, in the view of key scientists, not produced facts that are stable and certain. Nonetheless, new narratives have been produced and disseminated into the public imaginary. While my neuroscientist interviewees often claim they are apolitical, their goals are to produce excellent scientific knowledge that can ultimately lead to social change. We see involved actors doing politics in science, or as Sara Shostak (2013) aptly puts it "doing political science" to combat dominant discourses that they believe are not based in science and what is more, are socially and politically unjust. This chapter illustrated how stories about science are produced despite uncertain knowledge claims, and how imperfect science is used to nudge public opinion and governance in the "right" direction, towards greater scientific truth and social justice.

Chapter 6. The Brain in Context: Neuroscience for a Sociological Imagination

In the last chapters, I gestured to the fact that, despite a focus on the molecular and the individual, scientists I studied are interested in the role of social life in constituting our very bodies. These scientists arguably employ a version of what C. Wright Mills (1959) calls a sociological imagination in their scientific work. They make sense of the individual in his or her context, and give great explanatory power to the role of the social. Mills argues that we should understand "personal troubles" as they relate to history and society. I believe the policy-engaged actors I encountered over the course of my fieldwork understand personal troubles such as poor academic achievement and poor mental health as having an essential brain component. If they stopped here, it would appear that they are not examining the social and historical roots of personal troubles. However, the idea that social life is fundamental to brain development is essential to their perspective. The personal and the public are inexorably linked, where the brain itself mediates personal biology and social experience. The research is invested in these questions of how the individual and society interact as matters of both good science and social justice. And importantly, they understand the brain as the place where self and society intersect. Though they believe these phenomena can be studied through looking to the brain, they ultimately argue for social interventions, like increases to the minimum wage or enacting universal preschool programs. They use biomedical evidence strategically to draw attention to problems like poverty, inequality, and adversity.

The changes they advocate for usually have to do with reducing poverty and inequality, often through the use of social programs. But how can evidence about individual brains at the scale of mechanism – evidence that squarely aligns itself with a biomedical sensibility – be used to make changes on a larger, societal scale? One might expect that

knowledge claims about brains more firmly locate subjectivity and responsibility within the individual, as critics of (bio)medicalization, responsibilization, and molecularization suggest (cf. Clarke et al. 2009, Rose 2007). So how does biological evidence at this scale interact with extant discourses about individual and societal responsibility? In other words, how is this sort of evidence translated and packaged for social justice, to which ends, and what are the results of such efforts? Which visions of self, society, and social problems emerge? Which kinds of sensibilities does this research engender within researchers at the meeting of self and society, psychology and sociology, biology and culture, and nature and nurture? Which tensions and negotiations emerge? In this chapter, I begin to answer some of these questions.

Given their commitments to social justice, scientists were especially flummoxed when they were called racists and eugenicists; especially since they argue they are motivated by precisely the opposite beliefs. In Chapter 2, "The Science, The Stakes," I foregrounded critiques that scientists in this field, particularly those investigating the impact of socioeconomic status on developing brain structure and function, faced in their early careers from other scientists. Jenny Reardon's (2002) analysis of the scientists involved in the Human Genome Diversity Project tells a story of similarly well-intentioned scientists who are blindsided by charges of racism. How can we make sense of the competing meanings and criticisms that this field elicits? How do researchers respond to those critiques? How did work that was explicitly informed by progressive political aims to help poor children get implicated in these debates? Which politics does this research reflect? Further, what does it mean for science to be political, and who decides which projects are political? And why do they believe this project is not just benign (in terms of eugenic and racist ideas), but hopeful and full of the capacity to diminish inequality?

In this chapter, I give a detailed look at the kinds of critique the researchers face when attempting to bridge biological and social research. I argue this illustrates a distinct scientific and political approach – a perspective that aims to balance social and scientific, the political and the objective. There are three significant lines of critique my interviewees grapple with as the scientific consensus comes into being. First, critics worry that the perspective, findings, and policy implications have the potential to label poor people irrevocably broken at the level of the brain. They believe linking the social and biological in such ways is dangerous, and sounds alarmingly like historical attempts to classify human intelligence, personality, and capacity along biological lines and tie them, innately, to biological structures. They are of course referring to the studies and policies of phrenology and eugenics. The second criticism, which is closely related to the first, suggests that scientists are mistakenly turning poverty and inequality into brain problems, when they should be understood as social problems and addressed as such. They ask why social problems are increasingly subject to medicalization and biomedicalization. This critique takes issue with the assumption that individual, biological, and molecular level evidence is the best and only tool with which to study a phenomenon. Along with this go concerns about a biologically determinist and reductionist perspective. The last criticism is completely different, and has been articulated by more conservative individuals. They suggest that this work is explicitly political in nature; they argue that liberal ideas have hijacked "objective" neuroscience, ultimately putting the work and its implications into doubt.

In response, the scientists and policymakers I spoke with and observed put forward a number of claims. First, the theme of misinterpretation is strong, whether that misinterpretation is done by other scientists or lay publics. Fundamental in their explanation and response to their critics is the role plasticity plays in human development; plasticity is

deployed to fight the idea that early experience has a deterministic role in human wellbeing and life. However, scientists do not want to emphasize radical plasticity, and must balance discourses of plasticity with ones that suggest that early experience matters, and should be the focus of interventions. They also emphasize their interest in social justice and progressive causes, suggesting that politics is very much a part of their scientific lives. With regards to critique that suggests neuroscience is deterministic and reductionist, scientists see this as mostly a non-issue. As a matter of their training and perspective, they believe that life – both social and biological – oftentimes works via determinist and reductionist means,[31] or in the least, the scientific inquiry works in this manner. And further, most neuroscientists admit that, by virtue of their profession and perspective, they are biological and neuro determinists. This determinism, however, takes quite a different tack than social critics might anticipate. I argue below that it is a light version of determinism, at most. In these responses, I see different conceptions of brains, development, and science emerging. The complexity of the discourse has not been accounted for adequately[32] in studies focusing on biological determinism and the eugenicist underpinnings and implications of the work. The last significant response to criticism is stressing the objective nature of scientific inquiry, which is deployed in response to a wide range of criticism.

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[31] My scientist interviewees do understand the world and biological processes as exceedingly complex and multi-causal, but they nonetheless want to break down these vast and multifaceted phenomena into their constituent parts, and understand the mechanisms they ultimately believe underlies them. They believe the world is complex, and while they realize that it is nigh on impossible to account for this complexity in all its detail, those I interviewed believe it is worthwhile to acknowledge this fact, and try to account for it.

[32] With the exception, perhaps, of research covering the "interactionist consensus" that tells us that work in the life sciences is now operating under a new paradigm that acknowledges that both nature and nurture matter (Landecker and Panofsky 2013). My interviewees arguably share this viewpoint, but my work aims to explicate these details further.

While responding to criticism, my scientist interviewees must carefully manage a number of tensions around concepts like politics and objectivity; plasticity and permanence; science and policy, and scientific and social work. This tension is most evident in discussions of plasticity. These scientists and policymakers are in a tough position because while they do not want to suggest that experience produces permanent biological change at the level of the brain, they do need to argue that experience changes the brain, sometimes in ways that are detrimental for development and have effects across an individual's life course. If they suggest that the brain is very plastic, they undercut the message that early experience does matter, and that early childhood and education policy are worth attention and funding. Neither do they deny that some experiences or environments do cause permanent damage. Take, for instance, fetal alcohol syndrome. Without a doubt, exposure to alcohol in utero causes permanent changes and affects individuals for their entire lives. This kind of experience within the uterine environment (as strange, impersonal, and dehumanizing as this phrasing might be) is theorized to have has a long lasting impact. Studies of institutionalized Romanian children, conducted by some of my interviewees, quite clearly show that institutionalized children are deeply affected by these experiences, and have severe problems throughout their lives that are likely to be permanent (Nelson, Fox, and Zeanah 2014). The problem of what I call "broken brains" reflects the difficult task scientists and policymakers have in managing simultaneous discourses of permanence and plasticity. Further, they must balance desires for gaining public attention with worries of creating hysteria or overstating or misstating the implications of their claims. They believe that similar kinds of balance must be struck when discussing their role as scientists and political actors. I suggest, however, that it may be impossible to strike such a balance in this unstable and contentious domain. What is the result? A complex and interconnected vision that disrupts those dichotomies? A

reaffirmation of the existing hierarchy that privileges objectivity and pure scientific inquiry? After exploring the critiques and responses in detail, I discuss these and other questions. I will foreground for the reader, however, that my own analysis of the issues will also have this characteristic of managing tensions. I use Michelle Murphy's concept of "double vision" to suggest that this new neuroscience discourse is neither emancipatory nor oppressive, but always already both.

Criticism and Response

Psychopaths and Eugenicists

Considering that the emerging popular and policy discourses that link the effects of negative experiences on brain development to social problems like poor academic achievement, poor mental and physical health, criminality, and intergenerational poverty, one can see that things look bleak for children who experience early adversity. Both Foucault (1990, 1995) and Hacking (2002) argue that subjects come into being through the iteration of scientific knowledge, which enables but also constrains the possibilities of human experience. It is foreseeable then that these kinds of studies become loci of social control, creating and surveying a new class of deviant or potentially deviant children who are in the possession of bad brains. This criticism, then, is entirely expected and understandable.

A direct quote from one of my interviewees gets right to the heart of the issue. This pioneering researcher in the field recounted to me some of the first reactions to the research from other scientists:

> I'll tell you that the early, my early attempts to get funded to do this research were all rebuffed with really scathing reviews calling me-, basically name-calling, saying I was a reductionist, saying that I was pathologizing poor children, that I was suggesting that poverty is a brain disease. I mean, these are in quotes in reviews (Interview Jill).

She was incredulous. We had just spent a significant amount of time discussing her motivations for entering or creating this subfield of research. Prior to that, she worked as leading scholar in cognition and perception. She worked in a large urban center, and became interested in social issues. Reflecting on her own young child's upbringing – one that virtually assured her a path to success – she wondered how other children faired. She was concerned that minority children grew up in poverty, and tended to do less well in school. In policy and social science research, this disparity in academic performance is called the "Achievement Gap." Minority and low-income students tend not to perform as well as other students. This interest led her to read up on inequality, socioeconomic status, and racial disparities in health and education. Eventually, she brought her expertise in neuroscience and cognition into dialogue with her newly found knowledge on these social issues. Using what she termed her "neuroscience toolkit" – a way of thinking and assessing problems through the concepts and techniques of neuroscience – she attempted to theorize and later test the links between brains and social problems. Given her careful thought on and study of the social issues, she was surprised and offended by the response the work elicited. Why, she wondered, was she being called a eugenicist, racist, and phrenologist (by other scientists) when she was utilizing well-supported theories about social life, especially when her work engages with what most would call a progressive cause? This might be even more perplexing when public health studies regarding lead exposure – those which assert that poor, minority children are far more likely to be affected and permanently damaged by – are not accused of racist or eugenic means and aims.

If we take my findings from the last chapters seriously, then it is clear that my interlocutors are deeply concerned about the impact of this scientific work, and are careful in their discussions of its implications. Quite a few were worried that the data is "not there

yet." The aforementioned scientist is herself very cautious of how her research is deployed, and does not believe that the science to support clear policy recommendations has emerged. Other scientists and policymakers are more willing to harness knowledge claims that some may deem "uncertain" or "unproven" to support what they believe are the rights kinds of policies and practices. Those who have deployed the science into policy have done so to help children and families. Whatever their ultimate position, they all put a great deal of thought and time into how best to responsibly translate their findings into action, and questioned if the facts were even ready to be translated. In my observation, these individuals are demonstrably committed to providing children and families with social supports that mitigate inequality. Now, more than a decade on from Jill's first publications in 2004 and 2005, the scientific community is largely supportive of the research; the basic facts are considered sound, and the notion that experience shapes brain development is now conventional wisdom. The criticism is now mostly from outside of the field. Critics in the social sciences tend to reiterate that early criticism, however. They, too, express concern that the work pathologizes disadvantaged, minority children, and positions them as irrevocably broken. I will admit that this was my first reaction to the research. In fact, whenever I introduce my topic to social scientists they tend to express this sentiment. What were scientists' first experiences with this line of criticism, how did they react, and how do they respond today? And perhaps more importantly, how would I extract this information without damaging my relationship to my subjects? As it turns out, my fears were completely unfounded. Not only did they tell me about the "broken brains"[33] criticism, they often

[33] I termed this type of criticism "broken brains" early on as a shorthand.

brought it up first, and they wanted to speak about this contentious aspect of their research. They wanted to set the record straight, so to speak.

I begin my interviews by asking my subjects about their career history, and eventually, they tell about how the current research emerged. Early in our interview, Jill had this to say about how she came to study poverty through neuroscience:

> I was trying to get a handle on how the experience of growing up in a low SES family, in a low SES community, changes the way you think and respond to things – and again because the neuro toolbox is what I have – changes the way your brain functions. […] Well, first I have to say, the first hypothesis is that prefrontal function was going to be affected, it was going to differ. And that was just based on-, and I know that this really does sound like… [pause] I mean, it's really hard to talk about these things and not be misunderstood as saying pretty hateful things like, well, they have inferior brains so of course they're poor. (Interview Jill)

A postdoc I interviewed echoed that sentiment, and was particularly concerned with how lay publics interpret the work. Speaking of evidence from fMRI that shows differences in brain structure across socioeconomic status, she said

> it still needs to be informed, in my opinion, that the environment likely created a lot of what you are seeing in the scan, and of course that the environment can change that. I sometimes worry that laymen read certain neuroscience research and think, 'Oh they scanned poor people's brains and they look different than ours. They're just different.' […] It gets dangerous, especially when there are certain races that end up making the poorer populations. (Interview Alexis)

These scientists want to make sure that I know that they do not hold dangerous or hateful ideas. They also want to ensure that I understand exactly what the research argues and does not argue. The eugenicist and racist idea that poverty can be *explained* and *justified* by biological difference is one that these scientists find abhorrent and scientifically untenable. They maintain that this is a fundamental misinterpretation of the work. Their claims cannot and should not be compared, for example, with more recent pseudoscientific research linking IQ and race/ethnicity, namely, the infamous book *The Bell Curve: Intelligence and Class Structure in American Life* (Herrnstein and Murray 1994).

Another developmental psychologist and neuroscientist working on the effects of trauma on brain development and behavior reports that his research, too, was met with suspicion and derision. As a PhD student in the late 1980s and early 1990s, Sean studied childhood maltreatment. He was dealing with extreme abuse, of children "having experiences not typical for our species," like burning, choking, punching, physical abuse that is "likely to be permanently disfiguring," and leaving children unattended in dangerous situations (Interview Sean).

> Sean: […] I was studying their brain functioning, so people thought this was really weird. In fact, the very first time I wrote a grant as a graduate student, I wrote a grant proposal to study brain activity in abused children as they were processing emotional information. […] I wrote a small grant to do this, and I sent it to the National Institutes of Health, and the review panel for the grant wouldn't act on it. They deferred it.
>
> KT: Oh.
>
> Sean: They deferred it for two reasons-, and that's really rare. I have to say in twenty years, and having served on NIH grant panels, I've never heard of this happening. […] They felt that, wait a minute, you're taking traumatized children, and you're going to put electrodes and wires on their heads? They thought that this was barking up the wrong tree. One of the reviews that got passed along to me was what in the world would the brain have to do with the problems abused children are having? The real icing on the cake was one of the members-, this was also supposed to happen confidentially, right?
>
> KT: Right
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> Sean: One of the members of that review panel called my graduate advisor and said, I just read this grant application that [Sean] did, and said, what kind of person is this, is he a psychopath? Like what kind of person would take these young children having these kinds of problems and want to focus on the brain?
>
> KT: Wow.
>
> Sean: And my advisor said, he's a very nice person who cares about children
>
> (laughter)
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> Sean: That gives you some idea of, at that time, how unusual, how weird it was that leading people in the area really felt like, what does the brain have to do with child maltreatment? Now, of course, pick up any journal and it's impossible for

> people to actually be working in areas of mental health and child mental health and not be infusing biology into their studies.

Sean's motives and very character were questioned. At the time, looking for a biological corollary for poverty and trauma was suspect. These ideas, so unorthodox – perhaps because of the troubled history of studying the social and biological together[34] – appear to my scientist interlocutors ripe for misinterpretation. No one wanted to touch (or fund) these studies, possibly because of their historical and political baggage. Scientists I interviewed believe that both the intent and content of the work was misinterpreted.

The nature of the misinterpretation is explained in different ways by my interviewees. In the late 1990s and early 2000s, the first critiques came from colleagues and potential funders within their respective fields. Both Jill and Sean believe that the composition and expertise of their audiences was to blame. As we see from the quote below, Sean believes that his work was misinterpreted because none of his audience had any training in biology.

> One [problem] was that the panel that was comprised of the leading scientists studying child development and child welfare and behavioral problems. This panel of thirty had not one person who knew human biology. So that was one interesting thing in the 1980s. So they didn't think they could evaluate the methods I was using, and they were also very negative about it. (Interview Sean)

Sean argues that biologists would have known that he was not barking up the wrong tree, as biology, the brain specifically, is that which links social experience and behavior. He was theorizing links between sociality and biology in ways that he felt had yet to be understood in his field.

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[34] Aaron Panofsky investigates this troubled history in *Misbehaving Science: Controversy and the Development of Behavior Genetics* (2014).

Jill offers precisely the opposite explanation. Rather than resulting from a lack of scientific understanding, Jill explains that critics' ignorance of the sociological literature on race/ethnicity and poverty actually led to this misinterpretation.

> Well, yeah, it's so interesting. In fact really, I think the people who work on child poverty, the sociologists, […] some of them don't have any problem at all saying, yeah, look, their brains are affected by growing up like this. Whereas cognitive neuroscientists, they were so unfamiliar with discussions of these kind of issues. They were just really uptight and sort of puritanical about it, and we can't talk about this. One review I got said it was irresponsible of me to do research on this topic. Just crazy, right? (Interview Jill)

One of her graduate students during that time, Nicole, confirms that people in the area of social sciences and education were supportive of the work, while scientists were reticent. Unlike Jill who believes this is a matter of ignorance, Nicole suggests that neuroscientists were worried about politics, seeing in the work glimmers of the controversial and highly racist pseudoscience linking race and IQ: *The Bell Curve* (Herrnstein and Murray 1994). It is reasonable to assume that researchers doing biological research in the late 1990s and early 2000s, as many of my interviewees were, were hyper aware of these issues. As a result, they may have been understandably cautious about biological research making any claims about social issues. Regardless of the value that sociologists might have accorded to these studies, many neuroscientists were unwilling to support a project that they thought could be problematic and controversial.

> [sociologists] in the teacher's college were thrilled because they had been talking about this – socioeconomic disparities in child development – for decades and we were going to sort of bring from their perspective quote un-quote "hard science" this was perfect, this was legitimizing, this was wonderful. The cognitive neuroscientists, on the other hand, had a very different initial reaction where they were essentially saying why would you bring this complicated messy politicized topic into our clean world of brain science, you know, going to be viewed as the next *Bell Curve* […] (Interview Nicole)

Whatever the ultimate reason, Jill and Nicole tell us that cognitive neuroscientists were unable and unwilling to make links between the social and the biological. Jill was especially

surprised since she believes her work is supported by a sociological truism: poverty hurts health and wellbeing. By her logic, how could neuroscientists and psychologists take issue with her treatment of race and poverty, if sociologists and public health scholars – those with expertise in these areas – made arguments that were congruent with her findings? From her perspective, she was just expanding upon those sociological presuppositions, and giving evidence about the causal mechanisms involved. She believes this work to be complementary to those findings, and perhaps further, that all of these findings can be pulled together into a comprehensive understanding of how poverty affects human wellbeing. When it came to grant funding, it appears that the community was indeed concerned with politics or the appearance of politics. In the early 2000s, potential funders assessed Jill's grant applications, and she was strongly rebuked. A supportive colleague who had been witness to some of this criticism told Jill exactly how contentious the ideas were, and that the word eugenics was invoked.

> And he said there was a riot, people said you're bringing back the eugenicists, and he said, look, I can do a lot in terms of, you know, using my judgment to decide who to fund and not, but when the reviewers are like, over our dead bodies, I can't, I can't fund you. So in the end, he got us one year of funding, and that got us started, but yeah, that's really the way it was at first. (Interview Jill)

Though Nicole understands why it was difficult to fund the work, she argues that these comparisons to studies like *The Bell Curve* are not warranted. As I will discuss in great detail below, what makes this work distinct and scientifically valuable are theories of plasticity and environment. Critics, from the perspective of my interviewees, wanted to throw the baby out with the genetically determinist bathwater.

> in some ways [it] is such an unbelievable thing for a neuroscientist to say because a neuroscience person would say we very much know that there's early plasticity based on the environment. So in no way does an association between environmental and brain outcomes imply some kind of immutability or even genetic basis, and so, of course, I mean it's sort of fundamental, and so for them

> to be the ones who were protesting was in a way sort of shocking but we persevered. (Interview Nicole)

This contentious area of study is one that is haunted by an embarrassing specter of pseudoscientific attempts to justify the political and social oppression of entire classes of people. Learning from the examples of eugenics, race science, and phrenology, today's researchers are justifiably concerned about drifting outside of their narrow and objective areas of study, and into the fraught and subjective area of the social and political. It is just too risky and too complicated. For Jill and researchers following in her footsteps, it is just this kind of research, those tackling larger causal puzzles, that is most interesting to them. Further, it has the potential to answer the big, important questions. While discussions of mechanism are still integral to this type of research, Jill and others like her acknowledge how difficult it is to take that kind of reductionist approach:

> back in the old days, when I was happily doing [my previous] research, I would control my stimuli, control the experimental conditions, everything could be orthogonalized, all confounds were eliminated. When you're working with these social phenomena and social causes, all that is just impossible. (Interview Jill)

While it is difficult, they nonetheless try to address these interactions of society and biology. For Bogdan, this is what makes the field "exciting" (Interview Bogdan). Jill and others like her are different kinds of scientists who attempt to look at phenomena in a more holistic manner, and want to offer grand theories of social and biological functioning. Jill and I had the following exchange about her studies:

> Jill: […] we will have, for the babies, information about their home life, information about the mothers, mother's mental health, prenatal care, all this kind of stuff. And then with the 25-30 year olds, we have a bunch of questionnaires about stressful experiences they had, questions about their early childhood SES, so we can
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> KT: Sounds complicated to design studies like that. It must take a lot of work-, no?
>
> Jill: I mean, you know, yes and no.

> KT: It seems like you're doing sociological [research] and biological [research] and bringing them together
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> Jill: That is exactly what I see myself as doing!

Along with fMRI data, Jill and her team were collecting demographic and other data about the life and histories of their participants.

Jill also expressed shock at the assumptions that her critics were making about race and biology, and she found those to be far more offensive and problematic than anything she was hypothesizing.

> People were like, well, how do you know that the localizations that you're basing your tasks on from middle class people are even the same for low SES people, or even, how do you know the localizations from white people are even going to be the same for your African American subjects? I mean, like we're talking about different species or something, it was unbelievable! And again, these were the same people who, you know, were very righteous about the ethics of this, they were just assuming that they're not even like normal humans! (Interview Jill)

Jill noted that their rebuke was based on inaccurate, and perhaps even eugenic, notions that people of different races and classes have fundamentally different biology. Here, she begins to formulate a critique similar to one that Steven Epstein (2007) makes about biology and race. He suggests that while laudable, clinical trials and scientific studies aiming to include more than just white men into their trials reify notions that there are biological differences across racial and gendered lines. It is absurd, from Jill's perspective, that there is such a thing as a black brain or a low SES brain that one has from birth. Instead, brains are produced in a set of social relations that include race and class. They are not a blank slate at birth, but they are highly and necessarily mutable. From my discussion with Jill, I understand her to be making an argument that challenges eugenics. Rather than suggesting that some innate biological factor (be it brains or genes) determines our abilities and qualities, she suggests that environmental factors like poverty shape that biology, and that biology is almost always

malleable. One can imagine that Jill felt frustrated and misunderstood by criticism that she was a eugenicist and racist.

The criticism that Jill received in the early stages of her work left its mark. She believes her work was misinterpreted in those early years, especially by potential funders and other scientists in neuroscience and developmental psychology. Eventually, the work was accepted for publication, after being "rejected by all of the finest journals" (Interview Jill). She recounts that she was published because one editor believed in the project, and took up her cause. Scientists eventually came to support it fully. Vindicated or not, it is clear that these discussions of poverty and biological inferiority weigh on her, despite her belief that this type of criticism was "crazy," and a fundamental misapprehension of the work. She did not, and does not, want to be misunderstood as measuring brains of poor people, and justifying their social status through appeals to biology. She is hesitant, and still concerned that the work can be misconstrued; she wants to clarify that the work is not evidence of any biological inferiority of disadvantaged and marginalized populations. This way of thinking is consistent across all of my scientist interlocutors, and they have come up with different ways of managing criticism of the work. They deploy certain types of repertoires in response to criticism, which I detail below.

Plasticity Talk

One of the ways my scientist interviewees manage and explain the criticism they receive is by deploying discourses of plasticity or what I will call "plasticity talk." My scientist interlocutors explain the tendency towards audience misinterpretation of their work and motives in a fairly uniform manner. In the majority of my interview discussions about the "broken brains" problem, they would inevitably turn to plasticity to defend their position. One scientist gave a pithy response to my question about eugenics critique: "It's because the

public doesn't understand left-brain plasticity" (Interview Wanda). Others share this sentiment, but explain it more thoroughly, as we see in the quote from Nicole above when she was responding to this type of criticism: "we very much know that there's early plasticity based on the environment. So in no way does an association between environmental and brain outcomes imply some kind of immutability or even genetic basis." This is the paradigmatic response from proponents of this research. The issue, as they see it, is that their audiences do not understand the science of plasticity and developmental time,[35] and by extension, the complex interweaving of experience and the body, environment and genes, society and biology. That is, the audience is fundamentally wrong with respect to the idea that biology is innate and unchanging or that any experience causes permanent damage. Understanding plasticity helps scientist and non-scientist audiences understand how biology can change over time. Before getting into the details of plasticity talk, however, it is worth discussing why these audiences are "misinformed." Early attempts to emphasize early experience led to confusion. My interviewees hinted towards this issue, and with the help of Bruer's account (1999), I describe this history.

In the 1990s, President Bill Clinton and First Lady Hillary Clinton – in particular Hillary Clinton who spent a year at the Yale Child Study Center – worked very hard to emphasize early experience as a foundation for healthy functioning. In the White House, she organized a conference, Early Childhood Development, which was fundamental in putting early experience in the spotlight. For one of my interviewees, this powerful policy move may have created trouble for scientists working on brain development. My interviewee BM puts

[35] See also my discussion of developmental time and plasticity in chapter 2.

the blame on non-scientists, especially Hollywood director Rob Reiner, for speech he made at the White House conference:

> Back in the Clinton years they had a White House conference on Early Child Development, and the scientists were careful in pointing out what was possible. There wasn't as much information about plasticity, but then entertainers like Rob Reiner and so on came in, in a very heavy handed way, and said if we don't do anything before age two it's all over, so essentially it's back to back to biology is destiny. (Interview Steve)

Another one of my interviewees recounted a similar story, and suggests that such misinterpretations of science have policy effects, often for years to come.

> Hillary Clinton organized a White House conference on early childhood and at that meeting there were some psychologists, educators and neuroscientists, but the translation, […] of the message from that meeting was about the importance of the first years of life for brain development and obviously for adaptive behavioral development. And in fact there was a cover of Newsweek that had a baby sitting there and it said basically that everything that you did in those first months and year of life was critical in terms of brain organization and wiring and the other part of that message was if it didn't occur in those early years of life then you were finished because there was this sort of sensitive period during which it all had to occur, and if it didn't occur tough luck to you. And there were interesting spillovers to that. So the Governor of Georgia sent home [Mozart] audio cassettes.[36] (Interview Sandy)

Ironically enough, it appears that an emphasis on early experience led to a deterministic understanding of development; this discourse became dominant at the expense of theories of developmental plasticity. These ideas stuck, to the detriment of future research accentuating plasticity and contingency. Clinton wanted to tilt the discourse away from genetic and biological determinism and towards the suggestion that experience matters. Yet,

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[36] The issue of the Mozart Effect and the Georgia governor's policy proposal came up several times with interviewees. After hearing about the importance of early childhood brain development and the positive effects of classical music, Gov. Zell Miller argued that each newborn should go home from the hospital with music – to the tune of $105000. Even at the time, scientists were skeptical, suggesting that there was no clear evidence for this. (Sack 1998.) This is the example they use recount to illustrate the perils of using data that is "not there yet" to create policy.

the efforts to expand public understanding of science and push the nature versus nurture argument a little towards the nurture side (and also to contingency over innateness) reified a biologically determinist argument: "biology is destiny" and "tough luck." Instead of integrating nurture more thoroughly into the developmental model, this policy work unexpectedly led to the idea that experience matters for two years in which it has a deterministic, certain, and enduring relationship to future health and wellness. What my interviewees want to warn against are deterministic arguments of any kind. Researchers in a number of subfields of biology are, in fact, eschewing nature versus nurture arguments in favor of ones that theorize nature and nurture as always already intertwined and mutually constitutive. Policy and communication efforts in the 1990s did indeed lead to the insight that children are not "born this way," but my participants must now put a great deal of effort into explaining that these experiences do not produce permanent biological changes. Perhaps it is not so surprising that audiences have been confused about permanence and plasticity. As my interviewees tell it, this "ruckus" was the impetus for doing more research on brain development and neural plasticity. Notes Sandy:

> we [didn't] have any evidence that, there [was] no hard empirical evidence that the first years of life are critical for brain wiring, for organization, for later cognitive and social behavior. So that caused something of a ruckus and the McArthur Foundation […] put out a call for the organization of a research network that would bring together developmental psychologists and neuroscientists to basically discuss and think about these particular issues and particularly the issue of sensitive periods of early experience and what we know about it with regard to brain development. And so I was asked to be part of that research network and it was a group of developmental psychologists and hard core neuroscientists who study at the cellular level of brain […] In my scientific career, it was an important event because these meetings, we had meetings three or four times a year, these meetings were really important in terms of my thinking about the importance of the effects of early experiences in the first years of life and also sensitive periods. (Interview Sandy)

The MacArthur Foundation Research Network on Early Experience & Brain Development was funded from 1997 to 2009, and produced a wealth of knowledge about brain

development, including key insights about developmental time and neural plasticity. When interviewees like Sean and Jill faced criticism, especially of the broken brains variety, part of the difficulty was that many of the more definitive studies of brain development had not taken place or were in progress. And in fact, one interviewee told me that Jill's findings were central in clarifying some of the key claims about plasticity (Interview Violet). While Jill's student Nicole may think that plasticity is obvious and fundamental to neuroscience, it was not until they published their work that they had better evidence to support plasticity claims. As early contributors to this area of study, however, Jill and Nicole had few if any studies that could help them defend their position. Now, enough time has passed that scientists faced with criticism have these findings in their repertoire, and can deploy them to defend their concepts and claims.

Considering the issues above, my interviewees are keen to clarify these ideas, for both me, and by extension, the audiences they understand me speaking to.[37] They understand knowledge of plasticity as the antidote to the misunderstandings that emerged in the early 2000s when the research was in its infancy. Even though the scientific community has since validated the research, I have suggested that social scientists and humanists, along with the public, have more recently voiced similar concerns. Indeed, my scientist interviewees view discussions of plasticity with me and with other non-scientists as essential work in the process of science translation and policy implementation today.

It was clear that my interviewees were excited to get to discussions of plasticity. When it came to responding to broken brains criticism, plasticity was their trump card. They

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[37] Despite my best attempts to tell my participants that I was not a translator of scientific knowledge, nor was I a mediator between the worlds of science/policy/publics, they nonetheless foisted this role upon me.

were eager to explain to me how plasticity made this kind of criticism moot. Like good students eager to answer an exam question that they had studied for, my interviewees seemed to automatically launch into plasticity talk when faced with the vexing problem of audience misinterpretation. I moved into the topic with a prompt like the following: "what do you think of this criticism of the work, that it suggests that poor children are brain damaged?" The overwhelming sentiment was that it was a shame that good science had been misinterpreted and maligned in such a way, but that it was expected considering critics' lack of knowledge of neuroscience, especially plasticity and the nature of the brain. Plasticity talk often begins with my interviewees telling me how biology and behavior work:

> it was the advent [of plasticity], I mean people were beginning to do some of it in humans. Many of the people were doing it at that time were interested in temperament so they wanted this biological level more as a fixed, an immutable index of what biology gave you and then experience would give you something else. But true biology doesn't think that way. It has never thought that way. Biology is constant adaptation and behavior, by the way, is biological. I have never seen a rock engage in behavior, right? So human behavior is part of the adaptive program. It is biological and biological systems are adaptable and changeable, and nature is all about trying to survive and continue to function. (Interview Wanda)

These ideas are basic, but also revolutionary in the context of common and even expert understandings about both the body and brain's mutability. Communicating these more complicated truths about biology is challenging.

> It's not black and white. So I think it's difficult when you talk to the public. People, everybody, we like having black and white messages, categorizing things x, y and z, but that's not how biology occurs. It's extraordinarily complicated. (Interview Grace)

Below, another scientist talks plasticity, and also details some of its evolutionary advantages.

> from early in life, the brain architecture is being shaped by experiences we have and the pre-frontal cortex is the last to sort of grow in the tour and its successful development means good self-regulatory behaviors […] which is very important for success in the modern world. But if you look at different cultures, which have different rules, it will be shaping the brain in different directions. And one of the big challenges is if the brain is shaped in one direction and the person is

> transplanted into a different culture, what are the capacities for change, for plasticity? We used to think that is was negligible because the brain was fixed, but with all this knowledge of plasticity, neurogenesis, the re-organization of dendrites, the continual turnover of at least a sub-set of synaptic directions – all of this means that there is some potential for [change]. (Interview Steve)

My interviewees also made clear to me that plasticity is ongoing.

> brain plasticity is huge in the first three years and it continues to be. I think sometimes people mistake that 0-3 segment and think by age 4, forget it, you're done. It's certainly not like that. It's gradual and there're aspects of cognition that continue to develop well through adolescence. (Interview Nicole)

> Our brains are plastic now! My brain right now is not identical to any brain I have ever had in the course of my lifetime and it will continue to do that until I die and that's true for everyone. Even if that's true that a lot of the more […] "wiring" and the kind of deep stuff is harder to change. […] it's never entirely unchangeable. It might be that you just have to work a lot harder to get it to change. (Interview Jack)

> you know we focus on the early years because they are important but again like to assume that the early years are the only determining factors in one's later health is a fallacy.[…] Of course, we're very responsive individuals. There's brain plasticity occurring in adulthood. (Interview Grace)

> One of the best examples is that if you take somebody in their sixties and seventies who's a couch potato and is not physically active and you get them off their duff and they walk an hour a day five out of seven days, [it] enlarges their hippocampus, improves their executive function. It's an example of the fact that, you know, you 're never too old to benefit from things like this. And that's what giving us hope that we should not give up. (Interview Steve)

As is clear from the quotes above, scientists are keen to explain that brain development occurs over the life course. There is less agreement on how long these periods of plasticity – sensitive or critical periods – last. Some champion the idea that even the 80-year-old brain has the capacity for development, and therefore, can experience cognitive change in a positive direction:

> in terms of more complex cognitive functions, it doesn't seem like there's a sensitive period. What we do know is that brain development occurs by in a fashion such that circuits are laid one upon the other and it becomes harder with development to learn certain complex things than it is when you are younger. It is easier when you are younger to learn, but it's not impossible to learn. As you go into your sixties and seventies and eighties you can learn, it's just that the range of

> learning and the kinds of skills that you can learn is narrowed and the amount of effort that is necessary is greater. And that's the important message there. (Interview Sandy)

Wanda, along with other scientists at the vanguard of research into the manipulation of brain plasticity, believes we need a new metaphor to better communicate how the brain develops and changes over time. She suggests one: putting on the brakes. On diminishing plasticity over the life cycle, she argues the following:

> We reduce our plasticity. Continued hyperplasticity? Obviously nature didn't like that because we have all sorts of ways of reducing it to become more functional so there is this balance in being able to be adaptable and changeable and having some programs that have become more or less stable. […] So Takei [Hensch] is getting us to think more about the brain, [that] it doesn't become less plastic if you put it on the brakes. So plasticity is all about learning about how to release or let up on the brakes to let the brain do its natural plasticity thing. So we have stabilized brain plasticity with sensitive or critical periods. We change, we sort of put on some brakes so it stays that way. And that is very interesting, that is a different way of thinking about it. The brain is not less plastic. But […] we have put on brakes the other thing and so can we lift those brakes to re-adapt. (Interview Wanda)

The kind of brain that is theorized in the older critical or sensitive periods paradigm is one that is plastic during certain developmental phases, and then loses that plasticity. The brain that emerges out of the Wanda's new metaphor is always plastic. Rather than becoming plastic at certain points, biology must put on the brakes to reduce the brain's natural plastic, essentially mutable state.

While the details vary from scientist to scientist, most have well-rehearsed repertoires of plasticity talk they deploy when necessary. Plasticity talk is not identical but is consistent across my interviewees and participants. Through plasticity talk, they divert criticism that suggests biological changes at the level of the brain are immutable. Always underlying plasticity talk is a hopeful premise – the possibility of positive change. Babies are not cognitively hardwired by age three, adolescents and adults can do much to improve

themselves, couch potatoes can become healthy, and 80-year-olds can still learn new things. As I discussed in Chapter 3, scientists use the example of language acquisition to tell their non-scientist audiences about how plasticity and critical periods in brain development work. Learning a language is easier at a young age, but this does not mean that language acquisition is impossible for adults, it simply takes more effort. The brain can be "rewired" over the life course. Under this logic, we can see how neuroscientists take a hopeful view of their research. As Steve notes explicitly above, "that's what giving us hope that we should not give up" (Interview Steve). At no point is the brain finished developing, and any "wiring" can be adjusted.[38] When I asked PhD student Ginger what she wanted the public to know about socioeconomic status and brain development, she highlighted hope while also maintaining the importance (and potentially enduring effect) of early experience:

> I really like that question actually. I would want them to know that socioeconomic status can have really drastic effects on children's development for a variety of reasons. The stress that's involved with low socioeconomic status, resources that a family has access to, can really determine their developmental trajectory. So that's one thing that's important. You can't diminish the effect of socioeconomic status, and it will be important for people to keep that in mind as they move forward. But, on the other hand, another important thing to remember is that those effects are not intractable. […] Kids are also extremely resilient, and they can be very receptive to positive influences in the environment, speaking toward the importance of intervention and early intervention. So it's going to be mindful of the problems that individuals face as a result of socioeconomic status, be mindful of the potential of positive change that can come about. (Interview Ginger)

Scientists for Social Justice

When faced with criticism about broken brains, racism, and eugenics, several of my interviewees deploy another kind of response, highlighting their knowledge of, and commitment to, social and political causes. Scientists feel compelled to respond to the

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[38] We will have to wait and see, but perhaps the "wiring" metaphors will fall out of favor to better account for this continued plasticity. A structural metaphor that emphasizes greater fluidity would fit the bill.

criticism because they believe their status as good, ethical scientists and decent human beings is at risk. The majority of the people I interviewed, regardless of age and experience, came into this research with at least some social and political motivations informing their scientific interests. Oftentimes, these political orientations were foundational for their interest in the work.[39] What I came to understand is that criticism that suggests they are racist, eugenicist, or insensitive to the needs of families, feels absurd, even laughable to them. They believe it is off the mark on the most basic level.[40] These are individuals who have been involved in anti-racist and anti-poverty work for a long time. Given the seriousness of the criticism, they feel obligated to respond, and in doing so, they reveal their political and social motivations.

One can see the more explicit repudiation of the criticism in some of the quotes I have already presented from Sean and Jill. When called a psychopath, Sean recounts that his supervisor defended him: "He's a very nice person who cares about children" (Interview Sean). He seeks to have a policy impact in his current work, and has solicited collaborations with economists to make these arguments more clearly and effectively. He and I spoke easily about our progressive political views. When Jill and I discussed the issue that the work might pathologize poor children, she spent a great deal of time explaining how she wound up doing this work, and that it was informed by an interest in ameliorating poverty and inequality. She did not jump into the research naïve; she educated herself on the social science literature on class, race, and inequality. On the recommendation of a friend, she read

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[39] Owen, an early career scholar who trained with the pioneering figures in the field, is an exception to this. He had no real social justice aspirations, although he believes the work has clear applications for policy. He reports that he entered the field primarily because of the science.

[40] Of course, these kinds of proclamations alone do not mean that one's actions and beliefs are not subject to criticism. Merely refusing charges of racism or having anti-racist intentions do not necessarily mean that criticism is not warranted.

Oscar Lewis' classic on urban poverty and race, *La Vida* (1966). Further, she has made efforts to study the effects of socioeconomic status when most studies in neuroscience ignore this variable altogether. Most fMRI studies use middle class participants. Jill's attention to these issues suggests to her that she is one of the few neuroscientists who understands how significant issues of socioeconomic status and race are in America. This kind of criticism is especially ironic for researchers like Sean considering his difficulty on the job market, where the research was considered "social work."

> When I went on the job market, I was talking about my work on brain function in abused children. I literally had the professors in the clinical psychology program at one university, they sat there like this [with their arms crossed]. I went into one person's office, and she said, I don't understand why what you're doing that would contribute to a clinical psychology program, I don't understand why you're here. Why did you apply for this job? [They] thought this was a social work-, you know, abused children seemed like a social work problem. (Interview Sean)

Some of the researchers I spoke with do not have such a visceral response to this criticism, often because they only know of it as something that happened to the pioneers in the field a decade or more ago. Others are seasoned researchers who were not explicit targets of critique. They have a tendency to respond to such criticism with an eye roll before they move into plasticity talk. They roll their eyes because they believe the criticism is nonsense. The criticism is far less personal, and they mostly discuss it as a blip at the beginning of an otherwise fascinating and important research paradigm. Nonetheless, it is worth discussing how they respond given that both scholars outside of the neuroscience community and the public are reacting to the work – they are reiterating the broken brains critique. In response to critique, interviewees share with me their "developmental origins" in the field, and many, if not most, report that their scientific work is intimately linked to issues of equality and social justice. Nicole, for instance, worked in children's theater as an undergraduate student, working extensively with poor, minority children. A graduate student

I interviewed, Violet, reported social justice as a major rationale for doing a PhD in this area. She considers herself active in the social justice arena, and worked for Teach for America after college. Postdoc Bogdan was unsatisfied with his undergraduate education in neuroscience because it did not delve into the social causes of health disparity. He sought out a PhD program that would allow him to tackle these complex questions and to think about how neuroscience applied to the so-called real world. Helen, a self-described "hardcore" neuroscientist, is primarily concerned with improving children's experience in school, advocating for an approach that balances the academic and emotional needs of children. I also spoke with a number of pediatricians and MD/PhDs whose main motivation for doing what they do is helping disadvantaged children; many report working in clinics that serve marginalized populations or Medicaid recipients. These are only a few histories, and there are more. Most scientists I interviewed are explicitly interested in problems of inequality and children's wellbeing; they hope that the claims they make through neuroscience can be used (carefully) to inform new social interventions.

Many of my scientist interlocutors have explicit plans to use the science instrumentally to make an impact on discussions of poverty and adversity. Researchers use neuroscience to support findings that they know to be true from decades of literature in the social sciences. As I will suggest later in this chapter, they must manage competing desires to do both "social work" and objective scientific analysis. Violet reflects upon this issue. She recognizes the importance of using science strategically, yet finds herself in a quandary.

> KT: That touches on another issue that I'm interested in – science policy, science being evidence for better social policy, […] I hear a lot of scientists say that actually – we know certain things to be true and we know poverty is bad and we know that environmental pollutants are bad, but science helps us build that case. Is that what you're doing with your life?
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> Violet: In a way. I mean I think that's actually a thing I've really struggled with, what I see my role as because I know poverty is bad. […] And I think that was

> part of my motivation. My motivation was partly wanting to use the science to strengthen the case that we need to do more about poverty, and I think that is a little bit of a questionable thing when we think about what science is supposed to be. […] It's really at the point where [this research] can be marketed to say look poverty is changing brain. Now do we believe that it's bad? (Interview Violet)

Violet gets at a point that I will return to below. She must manage the tension between being informed by strong social and political beliefs, and believing in an apolitical and objective scientific ideal. While she knows that she does careful scientific work, she is mindful of the intrusion, or at least the appearance of intrusion, of politics into scientific work. The study of poverty may always look political to outside observers, and my interviewees understand that. They sometimes worry about studying poverty and inequality even though they have read plenty of quantitative and qualitative research that supports the claims they make about the negative impact of poverty. Regardless of these concerns, Violet believes that the research is solid enough that it can now be used to make changes at the social level, and what is more, she recognizes its unique capacity to influence public opinion and policy.

The Scientization of the Social

The second line of critique that I describe deals with what could be viewed as an intrusion of the biological sciences and modalities into the domain of social research. No doubt scholars in the social sciences want to reassert their stakes in this research terrain, and fear that the life sciences is colonizing those spaces (and research funds) they thought to be solidly under their purview. Beyond these seemingly petty squabbles about territory, there are serious concerns – what is at stake is not just who can create knowledge about phenomena but which kinds of research can take place. Will less "scientific" though valuable forms of research lose both funding and power to influence policy? Does this narrow the kinds of knowledge that can be made about social problems? Critics worry that studying social life with the methods of biology and neuroscience results in biologically determinist

and reductionist results. And surely, they argue, studying poverty as a biological problem, specifically a brain problem, is wildly inappropriate. And by extension, some suggest that the research privileges the individual, as both center of the modern subjectivity and scale of biomedical analysis. How is it possible for data from individual EKGs and brain scans to speak to issues of the collective? How can this help us understand complex social phenomena? Scientific study of issues like poverty and inequality appear insufficient and mismatched. And what of the political consequences of studying poverty as a brain problem? Would this not take the onus off of social causes and reframe them as individual, medical problems? Science studies scholars, myself included, may express concern that this supposedly objective research smuggles in other social and political values. For instance, biomedical evidence about individual brains is thought to reflect and reify individual responsibility and other neoliberal ideas (cf. Clarke et al. 2009).

With respect to charges of biological determinism, how do my interviewees react? Are they biological determinists? When I asked Jill about this, she does admit to a form of biological determinism, arguing "we're biological mechanisms" (Interview Jill). Wanda echoes Jill's sentiment:

> biology is constant adaptation, and behavior, by the way, is biological. I have never seen a rock engage in behavior, right? So human behavior is part of the adaptive program. It is biological and biological systems are adaptable and changeable, and nature is all about trying to survive and continue to function. (Interview Wanda)

Jill seems to suggest that all social behavior emerges out of this collection of biological mechanisms that we call the human body. That sounds like biological determinism on the face of it. She does not have a problem with this viewpoint – as seen above, both scientists willingly admit and defend that proposition. But I argue that she and others are engaging in what we might call a light determinism, if they can be categorized as biological determinists

at all. This light version is a hard idea to refute because, in essence, it suggests that social life is dependent upon being alive. Surely this is the base requirement for social interaction! It is not the same kind or degree of determinism one finds in genetic determinism, for instance, where some suggest that genes determine behavior.[41] Jill, herself, is critical of other neuroscientists who hold deterministic views of biology and race. Despite their defense of biological determinism, there seem to be limits to the level of biological determinism they support.

Other interviewees share similar ideas about the brain that we might call neurologically determinist. They believe in the brain as the prime mover of the self, and understand selves as arising from three squishy pounds of biology. When asked about biological or neurological determinism, a number of them suggest that one cannot be a neuroscientist without believing that the brain is the self, the self is the brain. This was often said with a shrug. The nature of the brain-self relationship was considered a philosophical question, and most did not feel equipped to answer these questions in a sophisticated way. Graduate student Aaliyah offered that, ostensibly, one has to believe in the primacy of the brain in order to do neuroscience research (Interview Aaliyah). Upon first glance, their answers suggest that they are such biological determinists that they cannot think of a world in which any other viewpoint is possible. When one looks at the entirety of the interviews, however, one can see that they operate through a different conception of the relationship between biological and social. Again, I argue we see my scientist interviewees contending with categories like biological and social often assumed to be dichotomous, and in doing so, they are working out a new synthesis that manages that relationship.

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[41] Genetic determinism turns out to be a far less simple discourse in practice. Very few scientists actually operate under this assumption.

For many of my interviewees, accusations of biological or neurological determinism miss the point. I suspect Jill and Wanda are trying to be a bit cheeky here about rocks not engaging in behavior and proclaiming us biological mechanisms, but their responses evidence their serious attempts to change the dialogue about determinism. They refute the premise that biological determinism is the appropriate response to their work. This is because my interviewees believe that biological mechanisms are highly malleable, and guided by processes that are often outside our bodies. One could argue that critics could accuse these neuroscientists of environmental determinism, considering the strong role they accord to experience. Perhaps more accurately, positioning them within the biological determinist or environmental determinist dichotomy is too simple. Jill holds a biologically determinist view of human beings, but not a view that any of these differences are innate. She, along with most of the people I spoke with in science and policy realms, represents a new kind of synthesis that has emerged out of the nature versus nurture dialectic. This is not dissimilar from viewpoints held by scientists doing research in epigenetics and other gene-environment interplay research where the nature versus nurture perspective is thought too simple a formulation. They may represent what some scholars have called an "interactionist consensus" (Landecker and Panofsky 2013) where nature and nurture are not diametrically opposed, but work in concert. This perspective, which privileges the dual role of nature and nurture, leads neuroscientists to frame brain development in specific ways. In his work on environmental epigenetics, Jorg Niewöhner (2011) found that the research conceptualizes a new kind of body, an "embedded body" that is "impregnated by its own past and by the social and material environment within which it dwells" (289-90).[42] My neuroscientist

[42] In my own work on the epigenetics field more broadly (Tolwinski 2013), I suggest that

interviewees may have similar conceptions of the brain, but they differ in some key ways. If I asked them, I suspect they would be reluctant to call the brain an embedded brain. The brain, by its very nature, is always already embedded, a product of experience par excellence. This is also one of the key ideas from the Harvard Center of the Developing Child – the very architecture of the brain is produced through interaction with caregivers. My interviewees would suggest that this has been their conception of the brain from the outset. There is no new paradigm for studying the brain, rather, neuroscience has always held this as its basic premise. A number of times, neuroscientists and psychologists I spoke with told me that the brain is more like an intermediary between the body and environment or social life (field notes). Whatever the exact discourse, it is clear that their discourses of brain and embodiment are something different from biological determinism. Is this new conceptualization of nature and nurture a good thing? For my interviewees, without a doubt it is. It produces a more holistic, complex view onto biological and social phenomena. Does it produce better science that takes social life into account in a sophisticated way? I will take that up in the discussion below.

To return to the question of scientizing social research, these neuroscientists see themselves as adding productively to these conversations rather than usurping the role of social science. Recall that these actors come to the problem of poverty and inequality with a sincere hope to make sense of and solve social problems, and that they utilize sociological and anthropological research as theory and also as a component of their research design.

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epigenetics does not straightforwardly represent an epistemological break from previous work in genomics. I argue that there is an array of viewpoints concerning whether and how epigenetics transforms research in biology. I am more willing to allow that the neuroscientists I study here push an interactionist discourse when discussing their work. I return to the question of whether an interactionist perspective really accounts for the social aspects of development in the discussion section below.

They know they bring the discourse of scientific objectivity to studies of poverty, and as I have argued throughout this dissertation, they do it self-consciously and strategically. This also transforms poverty and inequality more thoroughly into health problem, and further, one with significant economic implications. Here, medicalization is a powerful tool for transforming children's lives. Sean pulls together a number of themes here:

> It's not that I'm trying to reduce human behavior to the biology. […]There's another reason that maybe, this is what may catch your attention. What I like about this is-, is that for better or worse, we live in a society where biology is real. […] And to the extent that when I speak to members of Congress, policymakers, business executives, teachers, parents in the community, and I frame child maltreatment as a brain-based problem, it gets people's attention. It is not a social work-y kind of problem, it's not those people out there, it's not something that you think a counselor, some do-gooder in the world should try and go help. All of a sudden it's real. It becomes a health problem. It becomes a problem that might affect the gross domestic product. It becomes a costly and significant health problem. […]I think we should be concerned and responding the same way regardless, but it's motivating people. It's leading to more money, it's leading to more research, it's leading to recognizing child vulnerabilities as being a health problem, and the degree to which we've actually started to educate the general public about these being brain-based problems has increased it as a priority. (Interview Sean)

This quote highlights the strategic use of neuroscience, and also the fact that Sean thinks the social problem is important regardless of the way we conceptualize it. He suggests that science is an effective tool to illuminate a social problem, and grants it national attention. For better or worse, do-gooders and social workers have been easy to dismiss and thus ineffective.

As I have argued throughout the dissertation and will expand upon below, though they have turned brain development into a health problem affecting individual brains, their targets of intervention are not individual, biological ones. Their aim, instead, is the collective. As one neuroscientist put it, "[the research data] points the finger at society" (Interview Ginger). And, since it is their perspective that the social and biological are innately linked, they do not believe that these research programs should be distinct. It is thus not a mistake

to take a scientific approach, but a sensible one. As the brain is a biological entity that is built through social life, theories and methods that hold sociality and biology as intimately linked are best suited to studying it. I expand upon the issues that emerge from this perspective in the discussion.

Politics Not Science

I was told of yet another condemnation of the scientists I interviewed coming from more conservative critics. Criticism of this work, intriguingly, comes from both ends of the political spectrum. Quite recently – just before I had conducted the bulk of my interviews – a major media outlet covered one researcher's work on the links between poverty and brain development. She received hate mail for suggesting that socioeconomic status affects brain development. These conservative letter writers accused the scientists of using neuroscience to advance a liberal agenda. Just the fact that she said poverty was not something we can fix by getting people to pull themselves up their bootstraps incurred these critics' anger. Her very suggestion that inequality might be mitigated through social programs or direct funding (one of her new projects explores this hypothesis) elicits responses that she is a leftist who is doing bad, politically-motivated science. I have seen similar criticism on social media and online articles about this topic. For instance, a 2015 socioeconomic status and brain development study received wide attention. I saw a number of journalists covering the story. The topic garnered many comments, both on the online articles and on shared posts on Facebook. The comments are fascinating because they illustrate the full spectrum of reactions to the work (in the telltale extreme nature of comments sections): important, and even self-evident; verging on eugenics and evil; and liberal, snowflake, leftist propaganda. More recently, I saw a post on Facebook where a conservative critic said something to the effect of, "oh great, another bleeding heart study to blame Trump." These angry readers are

actually operating under a common assumption about what scientific practice should be – objective and politically neutral. Those who sent the aforementioned scientist hate mail accuse her of mistakenly pulling politics into the laboratory. Such concern with social problems and inequality is thought to poison the purity of the scientific endeavor. As we know from the literature in science studies and any experience with scientific research, however, science is never an unbiased, apolitical view from nowhere (Haraway 1991).

This interviewee and her graduate students were equal parts distressed and amused that people from both ends of the political spectrum take issue with her politics and scientific findings. They are not naïve, however, and do realize that studying contentious issues related to class, race, and inequality means that they will face criticism. They also have a sense that novel, unorthodox, and interdisciplinary scientific findings are often controversial. A considerable number of my interviewees had a difficult time convincing other scientists that their work was important, funding agencies of their legitimacy, and journal editors of the quality of their research. Theirs are stories of overcoming obstacles in the scientific community; they were vindicated when their peers not only accepted their work, but proclaimed it revolutionary. They understand this new criticism as a result of both the public's misunderstanding of science and a general anti-intellectual sentiment in the US. And they do believe the hate mail comes from the public because they maintain that only non-scientists would comport themselves in such ways.[43] That the public now misunderstands the work is an inconvenient, but perhaps expected, part of producing science about issues that have an impact on governance.

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[43] Without a doubt, we could all find scientists and other researchers who would comport themselves in inappropriate and unprofessional ways, but this is not the norm, and not typically how controversies unfold.

The recipient of hate mail was able to discount much of this criticism because the kinds of people who send hate mail to scientists are not typically credible or influential. Nonetheless, the hate mail is an extreme example of criticism that they do worry about – how do they assure audiences that they are doing apolitical work when they do have social and political interests? Recall Violet's lamentation above: "my motivation was partly wanting to use the science to strengthen the case that we need to do more about poverty, and I think that is a little bit of a questionable thing when we think about what science is supposed to be" (Interview Violet). Few were as explicit as Violet in describing the tensions evident between the ideal of scientific objectivity and personal interest in social issues. What typically happened in my interviews was a discussion that mirrors the structure I have laid out in this chapter. I would ask about the broken brains criticism, and they would respond by explaining plasticity and new ways of thinking about how brains and biology develop. Then they would respond with reiterating their professional trajectory that was most often a product of their interests in social justice and inequality. Because I knew that there was a conservative strain of criticism that took issue with their orientation towards social justice, I would ask them how they respond to people who say they are too steeped in political issues to produce credible and apolitical knowledge on the topic. Just as they were ready to deploy plasticity talk to dispel concerns about broken brains, they had a repertoire they used to respond to the conservative critique. Unsurprisingly, these researchers return to the ideal of objectivity as their guiding principle. They strongly maintain that they do not allow their beliefs about the negative effects of poverty to interfere with their study design, data collection, and scientific analyses.

The first way they bolster their objectivity is to emphasize that they came to their beliefs about the negative effects of poverty on children from extensive research. Almost

every interviewee told me there was scientific consensus that poverty has a negative impact on health. They cited not only sociological and anthropological sources, but also epidemiological studies from public health, especially from social epidemiologist Nancy Krieger whose body of work discusses the impact of race and socioeconomic status. That so-called "hard" or harder science[44] informs their propositions helps their cause. That other "objective" studies support the notion that poverty has negative effects on the body makes their hypotheses more difficult to refute as politically-motivated, illegitimate science.

The second way they respond is to always maintain that their beliefs can change with new evidence. So although they "know" that poverty is bad, they say they are more than willing to dispense with those hypotheses and the political positions if presented with compelling evidence to the contrary. It is unlikely that public health research will eventually suggest that poverty has a positive health impact at this point, so my interviewees' basic premise about poverty is likely safe. Nonetheless, they routinely argue that their views are subject to change. One graduate student emphasized how important a flexible orientation is to scientific study, even and especially with respect to those beliefs that we hold dear. He told me about an instance in which a scientific study changed his opinion on a political issue he was passionate about: gun control. Because he is open to expert study on the topic, he is now "chronically pro-concealed carry" (Interview Jack). His commitments to scientific study and objectivity force him to rethink "what [his] heart is telling [him]." He states something that I think most of my interviewees would echo when discussing scientific study: "I care more about the evidence than about being right. I don't want to be right, I want *us* to be

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[44] In the hierarchy of disciplines said to produce definitive scientific evidence, epidemiology does not occupy the highest position, but it undoubtedly beats out most sociology and anthropology.

right." This is of course an idealistic view on science and politics, but it is nonetheless what many of my interviewees maintain. Jill offers another example. While she has strong evidence that differences in children's brains are a function of socioeconomic status, she is not willing to argue (as she suggests some policymakers do) that all brain differences are environmental. She is open to the possibility that some of the differences could very well be genetic, and is willing to hear scientific evidence that suggests this. Again, she advances a flexible approach, and in so doing asserts her willingness to change how she thinks about both scientific and social issues. She recognizes that research positing a genetic basis for differences in brain size and structure are politically fraught – this would most certainly alarm those concerned about eugenics! It would be politically easier for her to say she knows definitively that differences in brain development have environmental origins. The way she tells it, however, she is more concerned with doing what she believes is the most accurate scientific work than doing what is easy, politically speaking. She thinks that it is easier to hold that it is only environmental difference that matters than it is to say that things are complicated, especially given her knowledge that policymakers want clear and certain facts. She offers an important caveat that I think is worth mentioning. If the causes of such differences were genetic, she would be just as vocal in her support of programs helping children who are disadvantaged, regardless of the cause. Even if it were as simple as an impairment being entirely innate, those children are still, and perhaps especially, deserving of care and funding.

> I mean, what if these things are genetic? So what? Does that mean we shouldn't try to help kids learn as much as they can and have as good lives as they can? You know, whether it's something that happens to their brains through the environment or whether it's something about the brains developing because of genetic differences they inherited from their parents […] Just because the differences are genetic doesn't mean that environmental experiences can't make up, shape, change them. (Interview Jill)

Note that in her conceptualization of development, even genetic differences are considered malleable. Where I believe Jill and other interviewees might be more explicitly political is in the assumptions that children are valuable and need care, social problems should be addressed, and human beings should strive for improvement. If I asked them about this, I suspect they would call these values universal, and reject that they are in any way political. For my interviewees, these values likely appear to be laudable whatever one's political leanings, and holding them is not considered damaging to one's objectivity.

For at least two of my interviewees, being apolitical and objective has less to do with being disinterested in social issues like poverty. It is more about whether or not they adhere to ideologies of one party or another, and for my interviewees working in the United States, this means they cannot be seen explicitly supporting the Democratic or Republican party platforms. They promote a specific definition of politics – big 'P' Politics. And though they have been active in policymaking, they argue they are not politicians who make policy decisions. Here they enforce a strong boundary between science and politics; though I see them as something between scientist and policymaker, here they suggest they are more or less communicating science. They take a "just the facts, ma'am" approach when asked about objectivity, and tell me it is very important to leave the rest to policymakers, lest they damage their credibility. This negotiation was evident in my discussion with Miles, a leading scientist interested in bridging neuroscience and policy. He can profess to me his interest in social justice and policies far left of center, but still maintain publically in news articles and privately to me that he "do[es]n't do politics" (Interview Miles) as long as he maintains some distance from formal governance. This discourse and approach of giving policymakers in both red and blue states the facts, and allowing them to take policy in whichever direction they choose, is a way to claim objectivity despite personal politics. As Wanda told me, she

and others want to get resources to parents to improve children's brain development, but stop short of giving politicians directives on policy. Child development is a thornier issue than one might imagine, and Wanda reports that one of the key political issues is what constitutes early childhood, and who controls children, parents or government. If one gets implicated in either side of that debate, "you've stepped in a giant dog doo" (Interview Wanda). When faced with concerns about excessive government intervention, "you have to work around helping parents have resources to be able to raise their own kids" (Interview Wanda). Practical political solutions in this context would not include government-run childcare programs, so it is important that scientists not frame the facts in such terms.

The language of "working around" does not sound precisely like remaining apolitical to me. It sounds like doing social and political work in strategic ways. My interviewees would likely report that they are doing what they can with the most broad, least controversial facts that they have to help children. They recognize that taking a stance on the government daycare versus stay-at-moms issue is a political one they do not need to wade into in order to get the job done. Scientists who do not "do politics" understand themselves as taking objective facts about child development and fitting them to the political context of a state. They can work within the political environment to build policy. By maintaining this boundary between scientific and political work, they find they can most effectively advocate for children and families while maintaining their credibility as objective, apolitical researchers.

Discussion

In the sections above, I have detailed how scientists respond to criticism of their work, and how that response illustrates a new way of thinking about topics like nature versus nurture, embodiment and development, and the relationship between science and politics.

My interviewees were eager to respond to criticism, and did so in a fairly uniform manner. To forestall criticism of racism and eugenics, they employ plasticity talk and also emphasize their interests in social problems. While my interviewees use their interests in politics and social justice to manage one form of criticism, this puts them in a more difficult position when faced with criticism that suggests they are poisoning science with those very commitments to social justice. To manage tensions that emerge within their research and in their roles as actors occupying some space between scientist and policymaker, they tend to uphold the ideal of scientific objectivity most strongly. When they do this, it takes the focus off of their social justice orientation, and back to what they believe is the unmediated truth that emerges from their data. My interlocutors are not being insincere at any point. They do hold onto both ideals – being both politically informed and objective – at once. I see them renegotiating the lines and relationships between seemingly dichotomous ideas like objectivity and politics, social and biological, plastic and enduring. In this, I see them building new conceptions of the body, scientific practice, and politics that have to this point made it difficult for analysts and critics to pin down exactly what the research does, the values it reflects, and its ultimate impact.

So how did the work truly emerge, and in response to what? Upon which politics and histories are these ideas built? Are they a continuance of eugenics and scientific racism? Is the work truly putting emphasis on the social? Put in more coarse terms, are these scientists racist, and is the work bad for poor, minority children? Are the scientists saviors who will put an end to poverty, and change the way scientists engage in debates about social problems? My answer is that things are much more complicated then they at first appear, and attending scientists' discourses on the topic illustrates just this issue. Just as their work questions and dismantles the boundaries between the social and biological, their perspectives

cannot be easily categorized and evaluated. Their responses do suggest, in my view, that their work is not merely an instantiation of a greater trend towards (bio)medicalization, molecularization, and the negative consequences critics level at these tendencies. This being said, these elements are undoubtedly present within the work and discourses around it, to both positive and negative effect. The research at once repudiates and reaffirms these ideas.

I believe there is no single clear and definitive accounting of how and why these claims emerged the way they did, and what they mean. To put it in scientific, mechanistic language, I do not believe there is clear cause and effect – no instance of scientific knowledge producing certain outcomes. The relationship is much more complex and recursive. I do not argue that a history and/or framework of eugenics brings this style of scientific thought into being. Nor do I suggest that this kind of research causes socially progressive policy to emerge. Things are not so clear and easy. Results are multiple and contested, and origins cannot be straightforwardly mapped. What I do argue is that a close look at the discourses and practices of scientists complicates the criticism we level at their work, and gives us greater insight into the development of the field. I take this constellation of critique and responses as evidence of a complicated terrain of competing discourses. This is to say that there is no right answer to the question of what the work is truly reflective of or what its implications truly are. Rather, this research is always already imbued with both emancipatory and repressive discourses. Dominant frameworks for explaining how biology and society work – notably, those that are reductionist, biologizing, individualizing, and arguably neoliberal – undoubtedly establish some of the conditions of possibility for the research. Simultaneously, however, that existing scientific and social order lays the ground for its critique. This is an example of what Murphy (2012) terms "double vision." Seemingly contradictory movements towards both emancipation and repression are evident in the story

of those who use neuroscience to study society. My interviewees study poverty through the lens of the neuroscience, and that is concerning for those who are worried that the increasing medicalization and individualization of social life. If poverty becomes a brain problem, the fear is that poverty will become an individual, biological problem. This potentially mean that individuals would have to mitigate this brain problem either by pulling themselves up by their bootstraps or seeking out medical treatment. A closer look at this work shows that while scientists utilize individual, biomedical data to produce knowledge about inequality, they recognize the social origins of these problems, are primarily concerned with targeting the collective, and are hopeful about changing children's lives for the better. This suggests that their work may reformulate this health issue in collective terms, "pointing the finger at society" (Interview LE). Whether society will be held responsible is question for the future. How the policy unfolds and interacts with existing discourses about how societies and bodies work is difficult to predict, especially as the work is in its early stages.

Do my interviewees' new conceptions of brains, bodies, and development lead to a new perspective that puts equal value on social and scientific research? I think that my interviewees would suggest this is the case, but I am far more skeptical. Darling et al. (2016), for instance, find that scientists working in the area of gene-environment interaction only measure the environment insofar as it can be molecularized, or put another way, transformed into discrete, quantitative measures. My concern is that this kind of research suggests it takes social life into account when it only takes a very specific, scientized version of it. When science claims to measure the social, what does it leave out, and will its status as an objective measure of all aspects of life lead it to supplant other less scientific forms of analysis?

Chapter 7: Conclusion

Through ethnographic analysis of neuroscientists, policymakers, and others, those I term "policy-engaged," I have examined the production of a specific set of neuroscience claims about the role of the social environment in constituting the developing brain. I have referred to this subfield and its discourses "social developmental neuroscience" (SDN). Using interviews, close readings of documents and other materials, along with participant observation in the science-policy world, I collected data about the science and politics early childhood brain development. Actors aiming to understand how environment and experience become "biologically embedded" have been the center of controversy, but have also been lauded for their attempts to reformulate scientific understandings of how environment and biology interact, to "point the finger at society," and to change policy in order to ultimately improve children's lives and alleviate social problems. The ideas expressed by scientists, policymakers, and critics gives us a view into society's collective and sometimes competing discourses around a whole host of issues concerning society, science, and the relationship between the two. These discourses also illustrate existing and evolving societal beliefs about personal responsibility, health, and governance. People involved in this area of research and advocacy want to reframe the issues of who is responsible for childhood brain development and what kinds of policies and interventions should be carried out for the good, not only of individual children, but also for society as a whole. I analyzed this neuroscience-based policymaking from the knowledge production phase to the early stages of policymaking and implementation.

In the introduction, I argued that I would build an empirical basis for testing the theoretical claims Nikolas Rose and Joelle Abi-Rached (2013) make, namely that neuroscience is merely the newest instance of turning social problems into biological ones,

and ultimately imploring individual parents to take responsibility for children at risk. This is consistent with critique from other Foucauldian scholars and those who study (bio)medicalization. While it may be true that this trend leads to formulating social problems partially as matters of brains and biology, I found that my interviewees used this insight to unanticipated ends. Far from using these scientific claims to sustain neoliberal notions of individuality and personal responsibility, my interviewees posed personal brain trouble as a public issue, and ultimately advocate for interventions at the social level. When I asked, "why bring attention to the brain?" I found that the rationale was both scientific and political. Many of my neuroscientist interviewees use science strategically to bring attention to social problems, and ultimately call for social justice and renewed responsibility for children's and families' wellbeing. I thus suggest that my case is illustrative of what Michelle Murphy calls double vision, where sociotechnical arrangements have a dual effect – they enable and constrain possibility all at once. I weave this thread throughout.

In the first substantive chapter, I wanted to inform my audience of the basic science that my actors were either involved in producing and using to rhetorical effect. Because it was difficult to clearly delineate actors and the research in this hybrid field, I used two reports that focused on neuroscience, early development, and adversity. I also expanded upon the controversial aspects of the research. I asked if biological research can ever escape its troubled past.

Chapter 3 is dedicated to understanding the science-policy relationship in greater detail, and how it plays out in the case I examine. Though the scientific reports of the previous chapter suggest there is a strong consensus around the scientific facts, I discuss cracks in that consensus, and suggest that there is a great deal of debate about these questions. What counts as credible, legitimate scientific knowledge is more controversial and

contested that it appears. I introduce the term "policy-engaged actor" to describe those individuals involved in building scientific claims and producing policy – these are scientists, policymakers, and those who lie somewhere in between. I argued that policy-engaged actors disagree about what counts as credible scientific knowledge, which claims can be used to inform policy, and which policies should be made. To influence governance, all those involved must negotiate the claims across the science-policy world. An idealized vision of the science-policy relationship holds that science is completed in the lab and then those findings are transferred to policymakers who will use it to make changes to laws, practices, and policies that affect the public. This version of how science-based policy works also suggests that problems arise because of a gap between scientists and policymakers. The actors I studied use the discourse of a science-policy gap to explain why it is difficult to translate lab findings into the so-called real world. I argued, using scholarship from science and technology studies on hybridity and boundaries, that lines between worlds of science and policy and non-science and science are inevitably ambiguous and contestable. These worlds are always already entwined. This means that it is not possible to clearly distinguish the science from its implications and translation. This orientation led me to suggest that there are no clear paths from science to policy, nor is there a gap that can be filled that would resolve these debates easily and clearly. Ultimately, these are complex negotiations about how to best study phenomena and order the world, and I argued that all the policy-engaged actors I studied have serious and reasonable concerns about using science in governance.

I illustrate how neuroscience is reformulating and reinvigorating discussions of poverty and other social problems in chapter 4. I answer why neuroscience may successfully bring attention to this domain. This analysis takes the shape of critical discourse analysis. I

used Maarten Hajer's (1993) concepts of "discursive affinity" and "discourse coalitions" to illustrate how policy-engaged actors integrate scientific, economic, and moral justifications to produce a new narrative around social problems. Hajer argues that discourse coalitions produce new storylines. I call this a narrative, and suggest that an assemblage of discourses about the strength of (neuro)scientific data, early childhood programs as a great return on investment, and societal responsibility to help innocent children may build a strong case for governing societies in different ways. The hope is that this narrative will create meaningful changes that improve the daily lives of families and also help address social problems, today and in the future. In Alberta, Canada, for instance, this narrative has had some success, and discourse coalitions wielding it implore the public to let go of a rugged individualist mindset. In such a way, policy-engaged actors pursue social justice and envision a better world.

Following from this discussion of discourse, chapter 5 focused on the production of a specific narrative called the "Brain Story," which was produced by Nancy Mannix, the Alberta Family Wellness Initiative, the Harvard Center on the Developing Child, and the Frameworks Institute. This case study provides insights into how science policy gets made, the negotiations around its development, and the aims of those developing it. They ultimately hope that this will encourage the public to think in new ways about early childhood development, and push for changes in governance and policy based on the credible scientific claims from neuroscience. I suggest these groups constitute a sociotechnical vanguard that offers up a particular vision – one in which biological evidence guides many facets of life, social and political.

When I embarked on this project, I was under the impression that my interviewees would not know about the criticism of their work, especially of the racist, eugenic, and medicalizing variety. They did, however, and wanted to speak to me about it. They spent a

great deal of time and energy explaining to me the nature of their work, their interests in social justice, and the ways that their critics misunderstood what they were trying to do. In chapter 6, I use Gilbert and Mulkay's (1984) method for understanding and analyzing scientists' discourse. I use their insights to build my own account of how scientists explain their work, especially how they make sense of and discredit criticism they receive. The responses I gathered had much in common, and I argue they help constitute a new vision of how research in science and political activism might take place. Seeing themselves as part of a new paradigm of studying the interaction of biology and sociality, they understand themselves as sometimes misunderstood, but ultimately victorious. The initial criticism from scientists in the field waned, especially as other researchers replicated findings or produced new findings to support foundational SDN claims. Neuroscientists I interviewed argue that their research is just another kind of study in the social determinants of health arena. First, they reiterate their good intentions, anti-racist and anti-classist sentiments, and aims to solve inequality. They argue they are informed by precisely the opposite of racism and eugenics. Next, they argue that their critics do not understand brain plasticity, which makes them mistake the brain and biology as innate and unchanging. They argue their perspective is quite the opposite of that which underlies eugenics. My neuroscientist interviewees thus argue that theirs is a hopeful project wherein the brain can be altered, and new prevention and intervention strategies can ensure that any child's life course can be rerouted and optimized. To counter the suggestion that they are bleeding heart liberals who are hijacking science for political purposes, my neuroscientist interviewees always maintain scientific objectivity as their highest value. I suggest that these findings may be surprising for scholars of biomedicine, as these actors do not argue that these problems can be fixed by looking to the individual. They offer up this biological evidence as proof that poverty and adversity are

social problems that must be addressed through interventions at the social level. They suggest that society is responsible for helping its most vulnerable and disadvantaged populations. Though their work is well-intentioned and perhaps poised to help families and alleviate inequality, I still worry that valorizing biomedical evidence is problematic and may result in labeling poor, minority children as irrevocably broken. I could not answer if such projects produce deviant subject positions or new broken brain kinds, mainly because the policymaking is in its infancy. The impact of such discourses is unknown, and without careful attention and taking responsibility for them, they may proceed in intended ways that may be very troubling. It is not just that these projects cannot escape their troubled pasts, they are troubled by their very nature, precisely because of the way they integrate social and biological analysis. This is a necessarily fraught area of study, but its complexity and implications for governance are also why so many policy-engaged actors believe they are worthwhile. Further, these scientific analyses that claim to measure social life do so in specific ways; namely, in ways that are scientifically legible. They should not be the only analyses that produce credible knowledge about social life. We should value knowledge gleaned from any number of methods from across the social sciences, humanities, and arts, and we would be remiss if only considered scientific and neurobiological evidence legitimate.

I understand my dissertation to accomplish three major tasks: 1) an in-depth examination of how a group of actors negotiate both science and policy to argue for new forms of governance that prioritize social justice; 2) an account of a relatively new and controversial subfield that aims for a more complex treatment of both social and biological facets of life; and 3) an examination of how this group of scientists conceptualizes social and biological life, produces a new synthesis emphasizing plasticity and environment, and

ultimately looks towards the future, envisioning new ways of organizing both scientific and political life.

I want to acknowledge the good work that my interviewees are trying to do, in the service of social justice, but also reflect upon the ways these actions reinscribe dominant ideas and power relations. When I reflect upon the researchers and knowledge claims emerging out of my study, I find Michelle Murphy's (2012) argument compelling: "thinking […] biopolitics is also about yearning to continue experimenting with technoscientific practices that could foster better means of enabling life with eyes open to the constitutive contradictions of an entangled world" (24). I aim to make sense of an entangled world of researchers, policymakers, audiences, interdisciplinary studies, knowledge claims, uncertainties, brain stories, and discourses around policy and governance. The people I study are trying to make sense of assemblages of brains, selves, societies, environments, experiences, and social problems. They did not expect that in diving into these scientific and social entanglements they were also necessarily engaging in discourses of race, class, eugenics, and neoliberalism. Further, they find themselves speaking and responding to multiple audiences and engaging with proliferating discourses about inequality, governance, brains, and selves in ways they did not anticipate. This is the nature of science-policy and biology-sociality hybrids. My neuroscientist interviewees found themselves at the center of contradiction. While they expected their findings to be a source of liberation, a weapon wielded for social justice, they found themselves accused of hurting the causes and the people they were most interested in helping. I am not personally committed to the projects linking brain development and social problems in the way Murphy is committed to feminist epistemology. I am equal parts critic and supporter – I, too, see from both perspectives.

What I found especially significant and surprising throughout this project was the way that dominant discourses of individual responsibility were transformed into ones promoting social responsibility through the use of evidence from neuroscience and economics. This story line puts forth a particular vision of selves, society, and social problems; I argue it emphasizes social justice, responsibility, and the role of society in our lives. These forms of inquiry and analysis are often critiqued as biologizing, molecularizing, and individualizing – on first glance, critics may assume that they evacuate the social entirely. On the contrary, the actors I studied self-consciously use these forms of evidence to promote more social and collective responses to societal problems. I have even gone so far as to argue that they use scientific (and perhaps biologizing, individualizing, and neurologizing) discourse to further promote a version of the sociological imagination (Mills 1959). They position the personal troubles and public issues as essentially linked, but they understand the brain as both the product of social life, and the tie that binds personal and public. Regardless of my interviewees' claims to doing good political work that emphasizes the role of social life, they had to manage how they spoke about the politics of their work. While undoubtedly political, they had to minimize any appearance of bias, and express ideals of scientific objectivity. My interviewees found themselves constantly navigating tensions between dualisms like objectivity and politics, sociality and biology, and permanence and plasticity. In such a way, I suggest that they promote new visions of scientific study and political action.

Appendix A. Adverse Childhood Experiences (ACE) Score Calculator

Below is a version of the ACE Score Calculator that I received at the conference, but it is also available from various internet sources. An ACE score of 4 or more increases the likelihood that the individual does or will eventually suffer from chronic disease.

While you were growing up, during your first 18 years of life:

1. Did a parent or other adult in the household often swear at you, insult you, put you down, or humiliate you or act in a way that made you afraid that you might be physically hurt?

Circle: Yes or No
If yes, enter 1: _____

2. Did a parent or other adult in the household often push, grab, slap, or throw something at you or ever hit you so hard that you had marks or were injured?

Circle: Yes or No
If yes, enter 1: _____

3. Did an adult or person at least 5 years older than you ever touch or fondle you or have you touch their body in a sexual way or try to or actually have oral, anal, or vaginal sex with you?

Circle: Yes or No
If yes, enter 1: _____

4. Did you often feel that no one in your family loved you or thought you were important or special or that your family didn't look out for each other, feel close to each other, or support each other?

Circle: Yes or No
If yes, enter 1: _____

5. Did you often feel that you didn't have enough to eat, had to wear dirty clothes, and had no one to protect you or that your parents were too drunk or high to take care of you or take you to the doctor if you needed it?

Circle: Yes or No
If yes, enter 1: _____

6. Were your parents ever separated or divorced?

Circle: Yes or No
If yes, enter 1: _____

7. Was your mother or stepmother often pushed, grabbed, slapped, or had something thrown at her, sometimes or often kicked, bitten, hit with a fist, or hit with something hard, or ever repeatedly hit over at least a few minutes or threatened with a gun or knife?

Circle: Yes or No
If yes, enter 1: _____

8. Did you live with anyone who was a problem drinker or alcoholic or who used street drugs?

Circle Yes or No
If yes, enter 1: _____

9. Was a household member depressed or mentally ill or did a household member attempt suicide?

Circle: Yes or No
If yes, enter 1: _____

10. Did a household member go to prison?

Circle: Yes or No
If yes, enter 1: _____

Now add up your "Yes" answers: _____ This is your ACE Score

References

Alberta Family Wellness Initiative. n.d. "Alberta Family Wellness Initiative – Building Better Brains." Accessed June 1, 2013. http://www.albertafamilywellness.org/.

Alberta Government. 2013. *Alberta's Social Policy Framework*. Edmonton, Alberta, CA: Human Services.

Ashmore, Malcolm, Michael Mulkay, and Trevor Pinch. 1989. *Health & Efficiency: A Sociology of Health Economics*. Philadelphia, PA: Open University Press.

Barnes, Barry and John Dupré. 2008. *Genomes and What to Make of Them*. Chicago, Il: The University of Chicago Press.

Bloor, David. 1973. "Wittgenstein and Manheim on the Sociology of Mathematics." *Studies in History and Philosophy of Science Part A* 4 (2): 173-191.

Bloor, David. 1976. *Knowledge and Social Imagery*. London: Routledge, Taylor & Francis Group.

Blumer, Herbert. 1971. "Social Problems as Collective Behavior." *Social Problems* 18 (3): 298-306.

Boyce, W. Thomas and Bruce J. Ellis. 2005. "Biological Sensitivity to Context: I. An Evolutionary-Developmental Theory of the Origins and Functions of Stress Reactivity." *Development and Psychopathology* 17 (2): 271-301.

Bradshaw, G.A. and Jeffrey G. Borchers. 2000. "Uncertainty as Information: Narrowing the Science-Policy Gap." *Ecology and Society* 4 (1): 7.

Bruer, John T. 1999. *The Myth of the First Three Years: A New Understanding of Brain Development and Lifelong Learning*. New York, NY: The Free Press.

Campbell, Bruce. 1985. "Uncertainty as Symbolic Action in Disputes Among Experts." *Social Studies of Science* 15 (3): 429-453.

Carabine, Jean. 2001. "Unmarried Motherhood 1830-1990: A Genealogical Analysis." In *Discourse as Data: A Guide for Analysis*, edited by Margaret Wetherell, Stephanie Taylor, and Simeon J. Yates, 267-310. London: Sage Publications.

Clarke, Adele, Laura Mamo, Jennifer Ruth Fosket, Jennifer R. Fishman, and Janet K. Shim, eds. 2009. *Biomedicalization: Technoscience, Health, and Illness in the U.S*. Durham, NC: Duke University Press.

Chandler, Jennifer A. 2015. "The Use of Neuroscientific Evidence in Canadian Criminal Proceedings." *Journal of Law and Biosciences* 2 (3): 550-579.

Coleman, Gabriella. 2017. "From Internet Farming to Weapons of the Geek." *Current Anthropology* 58 (S15): S91-S102.

Collins, Harry. 1985. *Changing Order: Replication and Induction in Scientific Practice*. London: Sage Publications.

Conrad, Peter. 1992. "Medicalization and Social Control." *Annual Review of Sociology*. 18 (1992): 209-32.

Coopmans, Catelijne, Janet Vertesi, Michael Lynch, and Steve Woolgar, eds. 2014. *Representation in Scientific Practice Revisited*. Cambridge, MA: MIT Press.

Crenshaw, Kimberle. 1991. "Mapping the Margins: Intersectionality, Identity Politics, and Violence Against Women of Color." *Stanford Law Review* 43 (6): 1241-1299.

Darling, Katherine W., Sara L. Ackerman, Robert H. Hiatt, Sandra Soo-Jin Lee, and Janet K. Shim. 2016. "Enacting the Molecular Imperative: How Gene-Environment Interaction Research Links Bodies and Environments in the Post-Genomic Age." *Social Science & Medicine* 155 (2016): 51-60.

Donovan, Joan. 2016. "How Many Stolen Lives?" Blog. *Occupy the Social*. http://occupythesocial.com/post/147020069698/how-many-stolen-lives.

Dumit, Joseph. 2004. *Picturing Personhood: Brain Scans and Biomedical Identity*. Princeton: Princeton University Press.

Dumit, Joseph. 2014. "How (Not) to Do Things with Brain Images." In *Representation in Scientific Practice Revisited*, edited by Catelijne Coopmans, Janet Vertesi, Michael Lynch, and Steve Woolgar, 291-313. Cambridge, MA: MIT Press.

Epstein, Steven. 2007. *Inclusion: The Politics of Difference in Medical Research*. Chicago: The University of Chicago Press.

Fausto-Sterling, Anne. 2000. *Sexing the Body: Gender Politics and the Construction of Sexuality*. New York, NY: Basic Books.

Felitti, Vincent, Robert Anda, Dale Nordenberg, David Williamson, Alison Spitz, Valerie Edwards, Mary Koss, and James Marks. 1998. "Relationship of Childhood Abuse and Household Dysfunction to Many of the Leading Causes of Death in Adults." *American Journal of Preventative* Medicine 14 (4): 245-258.

Foucault, Michel. 1990. *The History of Sexuality*. New York, NY: Random House, Inc.

Foucault, Michel. 1995. *Discipline and Punish: The Birth of the Prison*. New York, NY: Random House, Inc.

Geertz, Clifford. 1975. "Common Sense as a Cultural System." *The Antioch Review* 33 (1): 5-26.

Gieryn, Thomas. 1983. "Boundary-Work and Demarcation of Science from Non-Science: Strains and Interests in Professional Ideologies Scientists." *American Sociological Review* 48 (6): 781-795.

Gilbert, Nigel, and Michael Mulkay. 1984. *Opening Pandora's Box: A Sociological Analysis of Scientists' Discourse*. Cambridge: Cambridge University Press.

Goff, Phillip, Brooke Di Leone, Carmen Culotta, and Natalie DiTamasso. 2014. "The Essence of Innocence: Consequences of Dehumanizing Black Children." *Journal of Personality and Social Psychology* 106 (4): 526-545.

Grosz, Elizabeth. 1994. *Volatile Bodies: Towards a Corporeal Feminism*. Indianapolis, IN: Indiana University Press.

Hacking, Ian. 2002. *Historical Ontology*. Cambridge, MA: Harvard University Press.

Hackman, Daniel A., and Martha Farah. 2009. "Socioeconomic Status and the Developing Brain." *Trends in Cognitive Sciences* 13 (2): 65-73.

Haig, David. 2012. "Commentary: The Epidemiology of Epigenetics." *International Journal of Epidemiology* 41 (1): 13-16.

Hajer, Maarten. 1993. "Discourse Coalitions and the Institutionalization of Practice." In *The Argumentative Turn in Policy Analysis and Planning*, edited by Frank Fischer and John Forester, 43-76. Durham, NC: Duke University Press.

Haraway, Donna. 1991. *Simians, Cyborgs, and Women: The Reinvention of Nature*. New York, NY: Routledge, Taylor & Francis Group.

Heckman, James. 2006. "Skill Formation and the Economics of Investing in Disadvantaged Children." *Science* 312 (June 30): 1900-1902.

Hensch, Takao K. 2016. "The Power of the Infant Brain." *Scientific American* February: 65-69.

Herrnstein, Richard, and Charles Murray. 1990. *The Bell Curve: Intelligence and Class Structure in American Life*. New York, NY: Free Press Paperbacks.

Hilgartner, Stephen. 1990. "The Dominant View of Popularization: Conceptual Problems, Political Uses." *Social Studies of Science* 20: 519-539.

Hilgartner, Stephen. 2000. *Science on Stage: Expert Advice as Public Drama*. Stanford, CA: Stanford University Press.

Hilgartner, Stephen. 2017. *Reordering Life: Knowledge and Control in the Genomics Revolution*. Cambridge, MA: MIT Press.

Hilgartner Stephen and Charles Bosk. 1988. "The Rise and Fall of Social Problems: A Public Arenas Model." *American Journal of Sociology* 94 (1): 53-78.

Howlett, Peter and Mary S. Morgan. 2011. *How Well Do Facts Travel? The Dissemination of Reliable Knowledge*. Cambridge: Cambridge University Press.

Jasanoff, Sheila. 1987. "Contested Boundaries in Policy-Relevant Science." *Social Studies of Science* 17 (2): 195-230.

Jasanoff. Sheila. 1990. *The Fifth Branch: Science Advisors as Policymakers*. Cambridge, MA: Harvard University Press.

Jasanoff, Sheila, ed. 2004. *States of Knowledge: The Co-Production of Science and Social Order*. New York: Routledge, Taylor & Francis Group.

Jasanoff, Sheila 2005. *Designs on Nature: Science and Democracy in the United States*. Princeton: Princeton University Press.

Jorgensen, Marianne, and Louise Phillips. 2002. *Discourse Analysis as Theory and Practice*. London: Sage Publications.

Joyce, Kelly Ann. 2008. *Magnetic Appeal: MRI and the Myth of Transpa*rency. Ithaca, NY: Cornell University Press.

Kay, Lily E. 2000. *Who Wrote the Book of Life? A History of the Genetic Code*. Stanford, CA: Stanford University Press.

Keller, Evelyn Fox. 2000. *The Century of the Gene*. Cambridge, MA: Harvard University Press.

Keller, Evelyn Fox. 2010. *The Mirage of Space Between Nature and Nurture*. Durham, NC: Duke University Press.

Kellermann, Natan P.F. 2001. "Transmission of Holocaust Trauma – An Integrative View." Psychiatry 64 (3): 256-267.

Kukla, Rebecca. 2005. *Mass Hysteria: Medicine, Culture, and Mother's Bodies*. New York, NY: Rowman & Littlefield Publishers, Inc.

Krieger, Nancy, Diane Rowley, Allen Herman, Byllyle Avery, and MT Phillips. 1993. "Racism, Sexism, and Social Class: Implications for Studies of Health, Disease, and Well-Being." *American Journal of Preventative Medicine* 9 (6S): 82-122.

Lakoff, George and Mark Johnson. 1980. *Metaphors We Live By*. Chicago, IL: The University of Chicago Press.

Landecker, Hannah and Aaron Panofsky. 2013. "From Social Structure to Gene Regulation and Back: A Critical Introduction to Environmental Epigenetics for Sociology." *Annual Review of Sociology* 39 (2013): 333-357.

Latour, Bruno. 1993. *We Have Never Been Modern*. Cambridge, MA: Harvard University Press.

Lawson, Gwendolyn M. et al. 2013. "Associations between Children's Socioeconomic Status and Prefrontal Cortical Thickness." *Developmental Science* 16 (5): 641-652.

Layton, Lyndsey. 2015. "New Brain Science Shows Poor Kids Have Smaller Brains Than Affluent Kids." *The Washington Post*. April 15. https://www.washingtonpost.com/local/education/new-brain-science-shows-poor-kids-have-smaller-brains-than-affluent-kids/2015/04/15/3b679858-e2bc-11e4-b510-962fcfabc310_story.html?utm_term=.954fbb936765.

Lewis, Oscar. 1966. *La Vida: A Puerto Rican Family in the Culture of Poverty—San Juan and New York*. New York, NY: Random House.

Löwy, Ilana.1988. "Ludwik Fleck on the Social Construction of Medical Knowledge." *Sociology of Health & Illness* 10 (2): 133-155.

Lynch, Michael, Simon Cole, Ruth McNally, and Kathleen Jordan. 2008. *Truth Machine: The Contentious History of DNA Fingerprinting*. Chicago, IL: The University of Chicago Press.

Meaney, Michael and Moshe Szyf. 2005. "Environmental Programming of Stress Response Through DNA Methylation: Life at the Interface Between a Dynamic Environment and a Fixed Genome." *Dialogues in Clinical Neuroscience* 7 (2): 103-123.

McGowan, Patrick, Aya Sasaki, Ana D'Alessio, Sergiy Dymov, Benoit Labonte, Moshe Szyf, Gustavo Turecki, and Michael Meaney. 2009. "Epigenetic Regulation of the Glucocorticoid Receptor in Human Brains Associates with Child Abuse." *Nature Neuroscience* 12 (3): 342-348.

Mills, C Wright. 1959. *The Sociological Imagination*. Oxford: Oxford University Press.

Moss, Lenny. 2002. *What Genes Can't Do*. Cambridge, MA: MIT Press.

Murphy, Michelle. 2006. *Sick-Building Syndrome and the Problem of Uncertainty: Environmental Politics, Technoscience, and Women Workers*. Durham, NC: Duke University Press.

Murphy, Michelle. 2012. *Seizing the Means of Reproduction: Entanglements of Feminism, Health, and Technoscience*. Durham, NC: Duke University Press.

National Academy of Sciences. 2015. *Transforming the Workplace for Children Birth Through Age 8: A Unifying Foundation*. Edited by Allen Larue and Bridget Kelly. Washington, D.C.: The National Academies Press.

National Research Council and the Institute of Medicine. 2000. *From Neurons to Neighborhoods: The Science of Early Childhood Development*. Edited by Jack Shonkoff and Deborah Phillips. Washington D.C.: The National Academies Press.

Nelson, Nicole. 2011. "Capturing Complexity: Experimental Systems and Epistemic Scaffolds in Animal Behavior Genetics." PhD Dissertation, Cornell University.

Nelson, Nicole. 2018. *Model Behavior: Animal Experiments, Complexity, and the Genetics of Psychiatric Disorders*. Chicago: The University of Chicago Press.

Nelson, Charles, Nathan Fox, and Charles Zeanah. 2014. *Romania's Abandoned Children: Deprivation, Brain Development, and the Struggle for Recovery*. Cambridge, MA: Harvard University Press.

Niewöhner, Jorg. 2011. "Epigenetics: Embedded Bodies and the Molecularization of Biography and Milieu." *BioSocieties* 6 (3): 279-298.

Noble, Kimberly, Stuart Grieve, Mayuresh Korgaonkar, Laura Engelhardt, Erica Griffith, Leanne Williams, and Adam Brickman. 2012. "Hippocampal Volume Varies with Educational Attainment Across the Life-Span." *Frontiers in Human Neuroscience* 6 (307): 1-10.

Noble, Kimberly, Suzanne Houston, Natalie Brito, Hauke Bartsch, Eric Kan, Joshua Kuperman, Natacha Akshoomoff, David Amaral, Cinnamon Bloss, Ondrej Libiger, Nicholas Schork, Sarah Murray, BJ Casey, Linda Chang, Thomas Ernst, Jean Frazier, Jeffrey Gruen, David Kennedy, Peter Van Zijl, Stewart Mostofsky, Walter Kaufman, Tal Kenet, Anders Dale, Terry Jernigan, and Elizabeth Sowell. 2015. "Family Income, Parental Education and Brain Structure in Children and Adolescents." *Nature Neuroscience* 18 (5): 773-780.

Norlien Foundation. 2013. *AFWI's Knowledge Mobilization Strategy: Transforming Research, Policy, and Practice in Alberta*. Edited by Marylu Walters. Calgary, Alberta, CA: Norlien Foundation.

Norlien Foundation. 2014. *Accelerating Innovation: Telling the Brain Story to Inspire Action. Summary Report. Vol. 1*. Edited by Marylu Walters. Calgary, Alberta, CA: Norlien Foundation.

North, Anna. 2010. "How We're Already Killing Our Grandkids." *Jezebel*. August 1. https://jezebel.com/5443645/how-were-already-killing-our-grandkids.

Phelan, Jo, Bruce Link, and Parisa Tehranifar. 2010. "Social Conditions as Fundamental Causes of Health Inequalities: Theory, Evidence, and Policy Implications." *Journal of Health and Social Behavior* 51 (S): S28-S40.

Phillips, Nelson, and Cynthia Hardy. 2002. *Discourse Analysis: Investigating Processes of Social Construction*. London: Sage Publications.

Pinch, Trevor. 1981. "The Sun-Set: The Presentation of Certainty in Scientific Life." *Social Studies of Science* 11 (1): 131-158.

Pinch, Trevor, and Wiebe Bijker. 1984. "The Social Construction of Facts and Artefacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other." *Social Studies of Science* 14 (4): 399-441.

Pitts-Taylor, Victoria. 2017. "The 'Neural Phenotype of Poverty' and the Carceral Imagination." Presentation at the Society for the Social Studies of Science, Boston, September 2, 22017.

Presidential Commission for the Study of Bioethical Issues. 2014. *Gray Matters: Integrative Approaches for Neuroscience, Ethics, and Society,* vol. 1. Washington, D.C.: U.S. Department of Health and Human Services.

Presidential Commission for the Study of Bioethical Issues. 2015. *Gray Matters: Topics at the Intersections of Neuroscience, Ethics, and Society,* vol. 2. Washington, D.C.: U.S. Department of Health and Human Services.

Psychology Today. n.d. "Neuroscience Basics" Accessed February 1, 2017. https://www.psychologytoday.com/basics/neuroscience.

Rapp, Rayna. 2000. *Testing Women, Testing the Fetus: The Social Impact of Amniocentesis in America*. New York, NY: Routledge, Taylor & Francis Group.

Reardon, Jenny. 2005. *Race to the Finish: Identity and Governance in an Age of Genomics*. Princeton: Princeton University Press.

Rose, Nikolas. 2007. *The Politics of Life Itself*. Princeton, NJ: Princeton University Press.

Rose, Nikolas. 2010. "'Screen and Intervene': Governing Risky Brains." *History of the Human Sciences*, 23 (1): 79-105.

Rose, Nikolas and Joelle Abi-Rached. 2013. *Neuro: The New Brain Sciences and the Management of the Mind*. Princeton, NJ: Princeton University Press.

The Royal Society of Canada and The Canadian Academy of Health Sciences Expert Panel. 2012. *Early Childhood Development: Adverse Experiences and Development*. Edited by Michel Boivin and Clyde Hertzman. Ottawa, CA: Government of Canada.

Sack, Kevin. 1998. "Georgia's Governor Seeks Musical Start for Babies." *The New York Times*. January 15. http://www.nytimes.com/1998/01/15/us/georgia-s-governor-seeks-musical-start-for-babies.html.

Shostak, Sara. 2013. *Exposed Science: Genes, the Environment, and the Politics of Population Health*. Los Angeles, CA: University of California Press.

Smith, Laura. 2014. "John Bruer: 'Growing Up in Poverty Doesn't Damage the Brain Irretrievably." *The Guardian*. May 6. https://www.theguardian.com/society/2014/may/06/john-bruer-growing-up-poverty-not-damage-brain-irretrievably.

Spector, Malcolm, and John I. Kitsuse. 1973. "Social Problems: A Re-Formulation." *Social Problems* 21 (2): 145-159.

Timmermans, Stefan, and Marc Berg. 2003. *The Gold Standard: The Challenge of Evidence-Based Medicine and Standardization in Health Care*. Philadelphia, PA: Temple University Press.

Tolwinski, Kasia. 2013. "A New Genetics or an Epiphenomenon? Variations in the Discourse of Epigenetics Researchers." *New Genetics and Society* 32 (4): 366-384.

Waterland, Robert, and Randy Jirtle. 2003. "Transposable Elements: Targets for Early Nutritional on Epigenetic Gene Regulation." *Molecular and Cellular Biology* 37 (19): 5293-5300.

Weikart, David. 1967. *Preschool Intervention; A Preliminary Report of the Perry Preschool Project.* Ann Arbor, MI: Campus Publishers.

Wickens, Andrew P. 2015. *A History of the Brain: From Stone Age Surgery to Modern Neuroscience.* New York, NY: Psychology Press.

Woolgar, Steve, and Dorothy Pawluch. 1985. "Ontological Gerrymandering: The Anatomy of Social Problems Explanations." *Social Problems* 32 (3): 214-227.

World Health Organization. n.d. "Social Determinants of Health." Accessed September 1, 2016. www.who.int/social_determinants/en/.

Vidal, Fernando. 2009. "Brainhood, Anthropological Figure of Modernity." *History of the Human Sciences* 22 (1): 5-36.

Zola, Irving K. 1976. "Medicine as an Institution of Social Control." *Ekistics* 41 (245): 210-214.